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Engineering Equipment of an Educational Institution

MODEL UNDERGROUND DISTRIBUTION SYSTEM EMPLOYED IN CONNECTION WITH POWER PLANT OF UNIVERSITY OF CINCINNATI; AN INTERESTING FUEL PROBLEM

A CRITICISM OFTEN MADE of the curriculums of our engineering schools is the lack of sufficient practical training and the accompanying result of the student failing to appreciate his aptitude or inaptitude toward engineering until after he has been graduated, which accounts for occasional misfits in engineering jobs.

In an attempt to rectify this state of affairs, the University of Cincinnati, of Cincinnati, O., has introduced a cooperative course of study, as it is known, and which up to the present promises to be entirely successful. The course covers a period of 5 yr. of 48 weeks each, during which time the student spends alternately 2 weeks in class and 2 weeks actual work in some neighboring shop or power plant, performing the duties

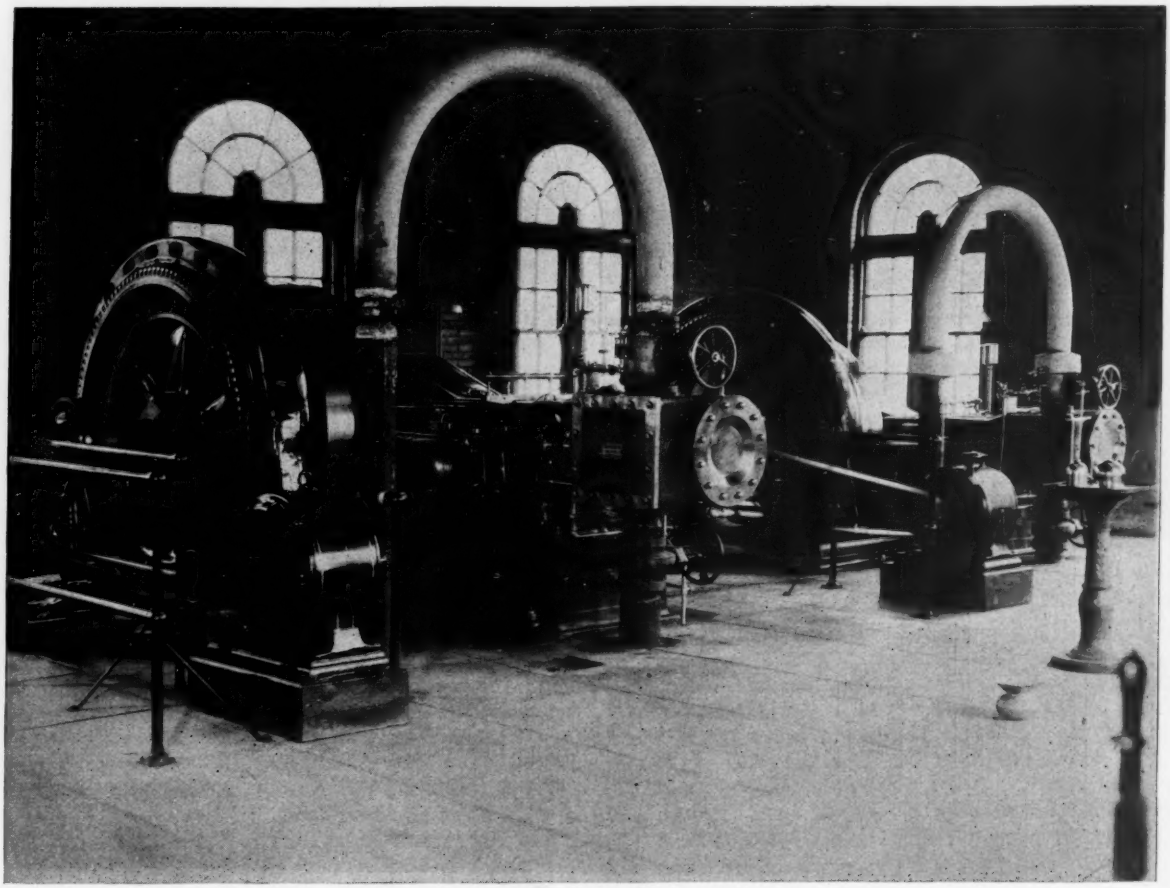
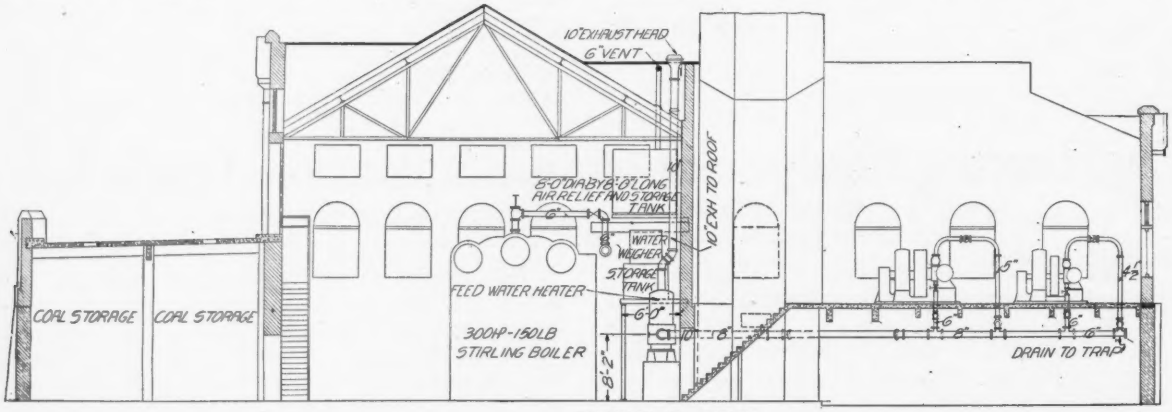


FIG. 1. MAIN GENERATING UNITS, POWER PLANT OF THE UNIVERSITY OF CINCINNATI

of a regular employe. In this manner, he can more readily determine whether he is fitted for his chosen profession before too late and, if he continues, can apply the money thus earned to defray a considerable portion of his college expenses.

This form of course in no way interferes with the regular mechanical and electrical laboratory courses offered, which are said to be equivalent to those of any other institution of technical education. And in order to make the work of those men following power-plant engineering as thorough as possible, a modern and well-equipped steam-electric plant erected to supply light, heat and power to the various university buildings is at their disposal for the purpose of test, investigation and research. This plant when constructed 4 yr. ago, cost approximately $50,000 for buildings and $148,000 for equipment, making a total of nearly $200,000.

The building housing the power-generating equipment is located directly in the rear of the engineering building on a natural slope of ground, and is of brick



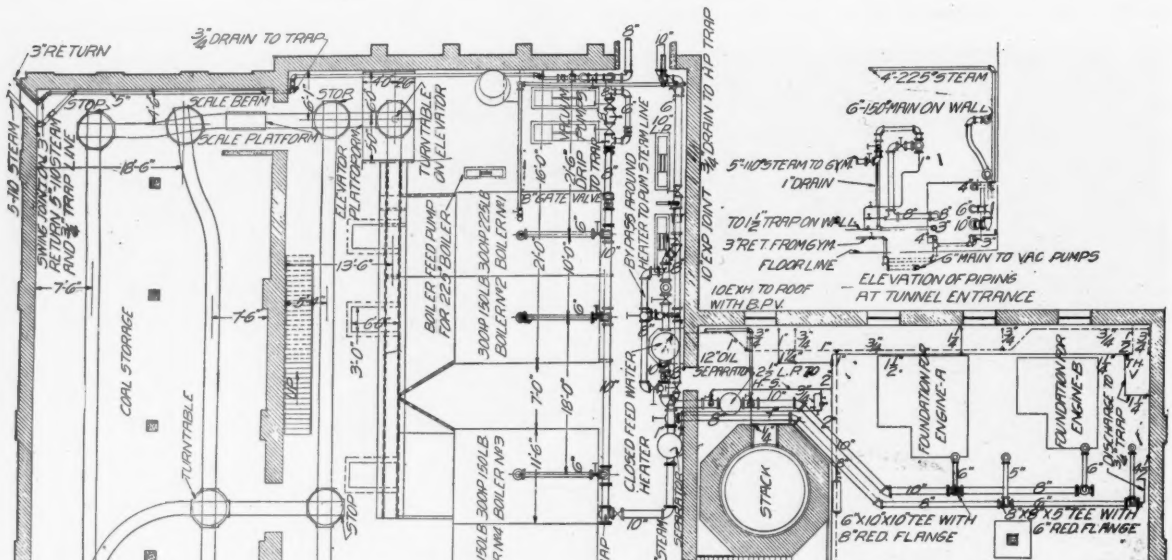


FIG. 2. PLAN AND ELEVATION OF POWER PLANT

and steel construction with green tile roofing. The exterior of the structure is of red brick with white trim, the interior of buff brick with oak trim.

As shown in Fig. 2, the power house is divided into 3 distinct sections, namely, the coal-bunker room, the boiler room and the engine room, the floor of which is at an elevation of 12 ft. above that of the boiler room. In the basement thus formed below the engine room are the repair parts and supplies room, and the firemen's dressing and toilet rooms.

Coal is delivered to the plant in trucks and wagons which by driving over the roof of the bunker room, discharge it through manholes into an unlined steel bunker, the bottom of which, in order to provide sufficient head room, is 8 ft. above the floor. This bunker, which is supported by the structural work of the building, is made up of 3/16-in. side plates and ¼-in. bottom plates and has a capacity of 250 tons. From here the coal is taken as required through either of 2 16 by 16-in. duplex coal valves and loaded into 1-ton cars of an industrial railway as illustrated in Fig. 3. These cars are then run onto the platform of a 2½-ton Howe scale, weighed, and moved onto a turntable forming the platform of a 2½-ton National hydraulic elevator, by means of which they are raised to the level of a track running on top of the stoker hoppers along the front of the boilers, where the coal is distributed as required.

Ashes are removed from the pits and shoveled into a car which when filled is weighed on another 2½-ton Howe scale and then raised by a National hydraulic elevator of like capacity to the ground level where they are dumped from the cars into wagons and hauled away. Figure 2, showing the plan and elevation of the plant, plainly indicates the routing of the coal and ash cars and location of scales and elevators.

In the design of this plant, due consideration was given possible future growth, the bunker room being of such proportions as to accommodate an ultimate capacity of 600 tons of coal, while the steam generating equipment may be increased by at least 50 per cent of its present rated capacity by boilers of a like size. The engine-room equipment may also be added to considerably.

The present steam-generating equipment consists of 2 batteries of 2 300-hp. Stirling water-tube boilers each, equipped with Murphy Automatic Smokeless Furnaces and Stokers and built for a working pressure of 150 lb. gage, except number 1, which being especially fitted for test purposes has been designed to withstand a pressure of 225 lb.

Steam is delivered through 6-in. branches to a 10-in. header running parallel to the rear of the boilers at a height of about 19 ft. above the floor line, and which in turn connects to 2 8-in. lines feeding the engines, the heating systems and the mechanical laboratories. Each boiler is equipped with a Vigilant feed-water regulator, 2 4-in. Lunkenheimer pop safety valves, a 6-in. Lunkenheimer non-return valve, a 6-in. gate valve, and 2 2½-in. blowoff valves, the one next to the shell being of the asbestos-packed plug type, while the other is a Lunkenheimer "Duro" angle blowoff valve connecting to a 3-in. blowoff header. This header discharges into a blowoff tank having a diameter of 3 ft. and a depth of 4 ft. and connects to the city sewers by means of a 4-in. drain.

The flue gases leaving the boiler pass through a sheet-iron breeching made up of No. 8 U. S. Gage plate reinforced by 2½ by 2½ by ¼-in. angle irons and having a minimum sectional area of 20 sq. ft. at number 1 boiler and a maximum of 55 sq. ft. at the stack entrance. The chimney, which is of yellow brick construction with ornamental terra cotta top, has an internal diameter at the top of 8 ft. and a height of 175 ft. from the boiler room floor.

FIG. 3. DUPLEX COAL VALVE AT BOTTOM OF BUNKER AND COAL CAR READY FOR FILLING; HOWE SCALE IN FOREGROUND

A Simmance-Abady CO_2 recorder connected between each individual boiler damper and the main breeching connection serves as a check upon the firing methods employed and the condition of the boiler settings.

Boiler-Feed Supply

Returns from the heating system, mechanical laboratories and auxiliaries about the plant are delivered to an 8 by 8-ft. cylindrical storage and air-relief tank provided with a 3-in. float valve which admits the required makeup from the city water mains. The water then passes through a 6-in. line into a Wilcox Water Weigher having a capacity of 62,500 lb. per hr. and thence is delivered to a Sims closed feed-water heater capable of raising the temperature of 27,600 lb. of water from 50 deg. F. to 208 deg. F. each hour by either one of 2 8 by 5 by 10-in. Blake-Knowles boiler feed pumps. The 4-in. feed line running along the rear of the boilers is fitted with a spring-loaded relief valve set for a maximum pressure of 165 lb.

For purpose of test in connection with number 1 boiler, a 500-hp. number 4 Detroit Water Meter and a 6 by 4 by 6-in. Blake-Knowles high-pressure feed pump have been installed.

In the Engine Room

Here are located the electric generating units, the switchboard and the chief engineer's office and dressing and toilet rooms.

Electric current is obtained from either one or both of 2 generating units depending upon load demands. One of these units consists of a 175-kv.a., 2300-v., 3-phase, 60-cycle Triumph alternator direct connected to a 15 by 18-in. Skinner automatic high-speed engine and the other of a 125-kv.a. machine of like make, voltage and frequency direct connected to a 13½ by 16-in. Skinner engine. Each unit has its individual belted exciter.

FIG. 4. BOILER FRONTS AND MURPHY AUTOMATIC SMOKELESS FURNACES AND STOKERS

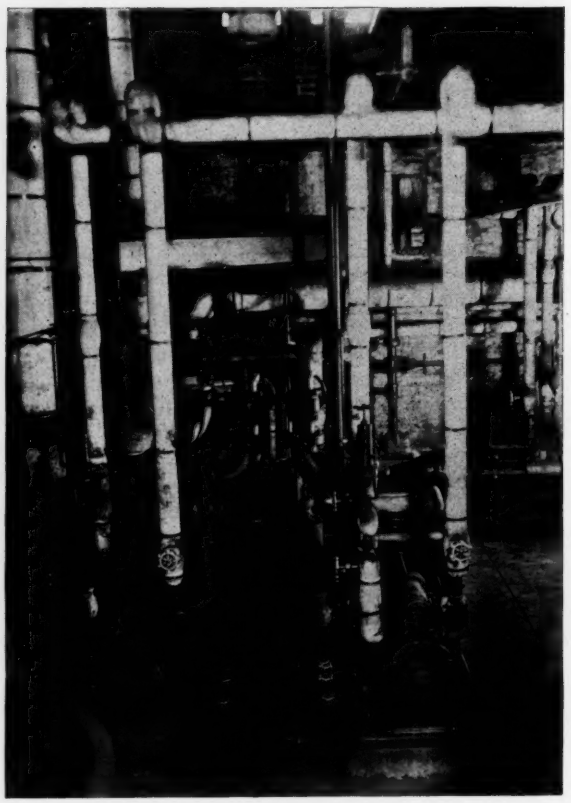


FIG. 5. THE VACUUM AND BOILER FEED PUMPS ARE READILY ACCESSIBLE AND CONVENIENTLY LOCATED

The switchboard, placed directly opposite the engines as shown in Fig. 2, is built up of 7 black slate panels for the control of the exciters, the main generators and the 6 light and power feeders. A Tirrill regulator mounted on the exciter panel insures close voltage regulation and by means of a double set of distribution bus bars, the power and lighting circuits may be isolated one from the other and thereby any voltage drop due to excessive current flow during tests in the electric laboratories may be reduced to a minimum and practically be unnoticed on the lighting circuits.

Each of the 6 outgoing circuits is protected by an inverse time-limit overload relay and an oil circuit breaker and for checking current consumption is provided with an integrating watt-hour meter in addition to the 2 watt-hour meters and 2 curve-drawing wattmeters connected to the main bus bars.

All switchboard equipment is of General Electric Co. make.

In the chief engineer's office is a marble gage board carrying 2 high-pressure steam gages, 1 low-pressure steam gage, 1 vacuum gage and a clock.

Electric and Steam Distribution

All steam lines, returns and electric conduit, except those supplying the gymnasium, are carried to the various buildings about the campus in a reinforced concrete tunnel approximately 6½ ft. wide by 7½ ft. high and having a total length as shown in Fig. 6, of nearly 1300 ft. The ducts carrying the electric conductors are imbedded in the concrete roof while the piping is carried along the sides of the tunnel being mounted on roller-bearing saddles supported by brackets built up of angle irons and gusset plates riveted to 3½ by 3½ by ½-in. angle irons which in turn are fastened to the wall by expansion bolts at a maximum distance between centers of 12 ft.

The entire tunnel was installed in an open trench varying in depth from 10 to 35 ft.

Special provision for proper drainage has been made by placing 4-in. porous tile on each side of the tunnel just beneath the floor line. This tile is connected at numerous points with the surface and with adjacent sewer lines. The roof is protected by 3 layers of felt,

each carefully mopped with a waterproofing compound and lapped down 1 ft. on each side. A gutter connecting with a number of cesspools draining into the city sewers is run in the floor of the tunnel to provide for the drainage of water used for flushing or coming from possible leaks in the steam pipes.

anchors consisting of hydraulic couplings are tied in as illustrated in Fig. 7.

The comparatively great distances which both electric energy and steam are transmitted introduced the problem of consequent excessive loss. To avoid this, and at the same time keep the size of piping and electric

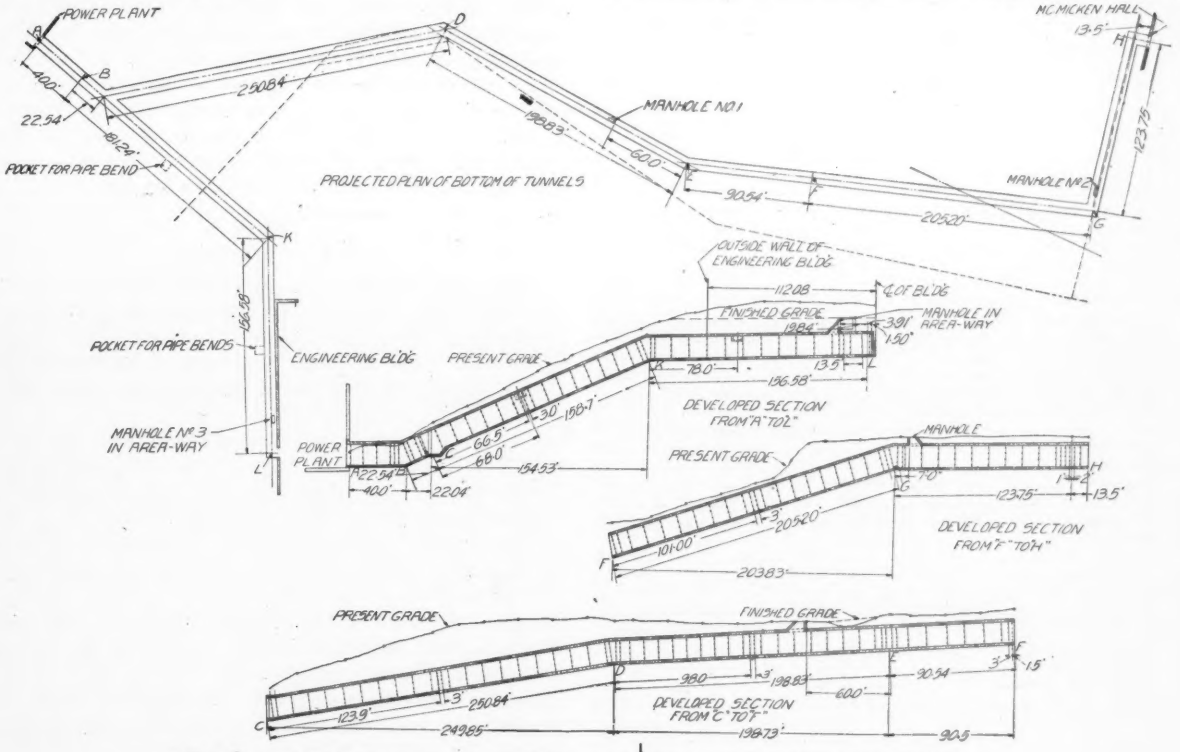


FIG. 6. PROJECTED PLAN OF BOTTOM OF TUNNEL WITH SECTIONAL DETAILS

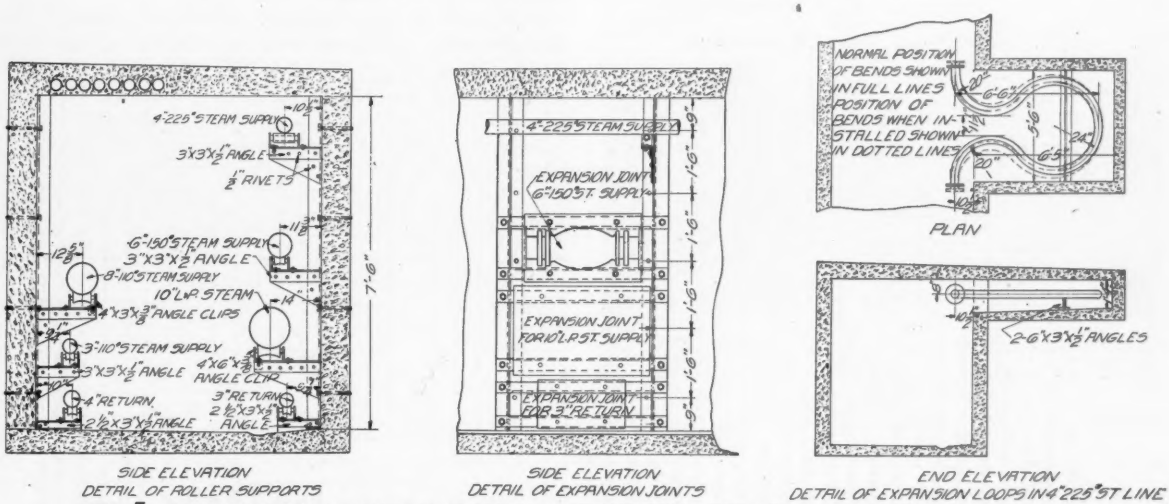


FIG. 7. TUNNEL DETAILS SHOWING METHODS OF SUPPORTING PIPE LINES AND CARING FOR EXPANSION

Expansion in the high-pressure piping between the power plant and the engineering building is cared for by 2 expansion loops located as shown in detail in Figs. 6 and 7, respectively, while slip joints mounted as in Fig. 7, compensate for expansion on all other steam and return lines. The maximum distance between any 2 expansion joints or loops is 300 ft., and between them conductors installed as small as consistent with satisfactory service, both steam and electric current are transmitted at high pressure. The steam employed in the mechanical laboratories is for obvious reasons transmitted at boiler pressure, while that used for heating is reduced from 150 to 75 lb. by means of an 8-in. pressure-reducing valve. Low-pressure, or exhaust steam not exceeding

5 lb., is used in the Engineering and Chemistry Buildings. Another reducing valve located in each building supplied, again reduces the pressure to that required for the individual heating system. In a like manner, electric current is transmitted at a voltage of 2300 and stepped down to 220 and 110 v. by suitable sized transformers installed in fireproof rooms in each building served.

DAILY POWER PLANT REPORT.

UNIVERSITY OF CINCINNATI.

Date.....January 7.....1914

Started up	6:30 A.M.	Shut down	10:00 P.M.	Total	15½	Hrs.
Boiler No. 1	On 6:00	Off 10:00		Total	16	Hrs.
Boiler No. 2	On	Off		Total		Hrs.
Boiler No. 3	On 6:00	Off 9:00		Total	15	Hrs.
Engine A	On 6:30	Off 10:00		Total	15½	Hrs.
Engine B	On	Off		Total		Hrs.
Boiler Feed Pump No. 1	On 6:30	Off 10:00		Total	15½	Hrs.
Boiler Feed Pump No. 2	On	Off		Total		Hrs.
Boiler Feed Pump No. 3	On	Off		Total		Hrs.
Vacuum Pump No. 1	On 6:30	Off 9:00		Total	14½	Hrs.
Vacuum Pump No. 2	On	Off		Total		Hrs.
Heating System	On 6:30	Off 9:00		Total	14½	Hrs.
Day Engineer	On 8:00	Off 5:00		Total	9	Hrs.
Night Engineer	On 1:00	Off 10:00		Total	9	Hrs.
Assistant Engineer	On 6:00	Off 4:00		Total	10	Hrs.
Day Fireman	On 6:00	Off 4:00		Total	10	Hrs.
Night Fireman	On 1:00	Off 10:00		Total	9	Hrs.
Fireman's Helper	On	Off		Total		Hrs.

Coal furnished by ..... Reliance Coal Co.

Kind of coal ..... New River Nut & Slack

Coal received	8980			Lbs.
Coal consumed	20225			Lbs.
Ash removed	2200			Lbs.
Current for Light	(13695)-(13154)	=	541	K. W. Hrs.
Current for Power	(73850)-(73760)	=	90	K. W. Hrs.
Total Current			631	K. W. Hrs.
Feed Water	(149520)-(149232)	=	265620	Lbs.
City Meter	( )-( )	=		Cubic Feet
Average Steam Pressure	132			Lbs.
Average Feed Water Temperature	208			Degrees.
Mean outside Temperature				Degrees.

Remarks .....

Signed... Edward Bittner.
Chief Engineer.

FIG. 8. TYPICAL DAILY OPERATING RECORD

OPERATING RECORDS

FIGURE 8 is a reproduction of a daily operating report of the power plant. It indicates, as may be seen, the running time of the various units and auxiliaries, the number of hours put in by the engineers and firemen, the kind and quantity of coal received and consumed together with the number of pounds of ashes removed; it also provides space for the readings of the watt-hour meters, the water meters and the average steam pressure and feed-water temperature. From the information thus at hand the weekly average number of tons of coal consumed per 24 hr. and the average number of pounds of water evaporated from and at 212 deg. F. per pound of coal consumed are plotted on charts such as shown in Fig. 9.

THE FUEL QUESTION

THAT the lowest priced coal obtainable for power plant use is not always ultimately the cheapest is shown in an experience of the authorities of the University of Cincinnati. In July, 1914, the Board of Trustees, at the suggestion of the Mechanical Engineering Department of the University, placed their order for one year's supply of New River nut and slack smokeless coal at a cost of $2.75 per ton and with a guarantee of 14,800 B.t.u. per lb. and not more than 6 per cent ash. Their former contract had been for Logan nut and slack—a soft coal—having a guaranteed heating value of not less than 14,000 B.t.u. per lb. and not more than 10 per cent ash, and at a price, July, 1914, of $2.38 per ton. The difference in price of these 2 coals was not justified on the basis of guaranteed heat content alone; but the Mechanical Engineering Department recommended the higher priced coal as being more economical, believing that the saving in first cost would be more than offset by the increased evaporation and by the saving in furnace repairs due to the absence of clinker and slag.

To prove their contention, tests were conducted for that purpose. Comparison of the heating values of the

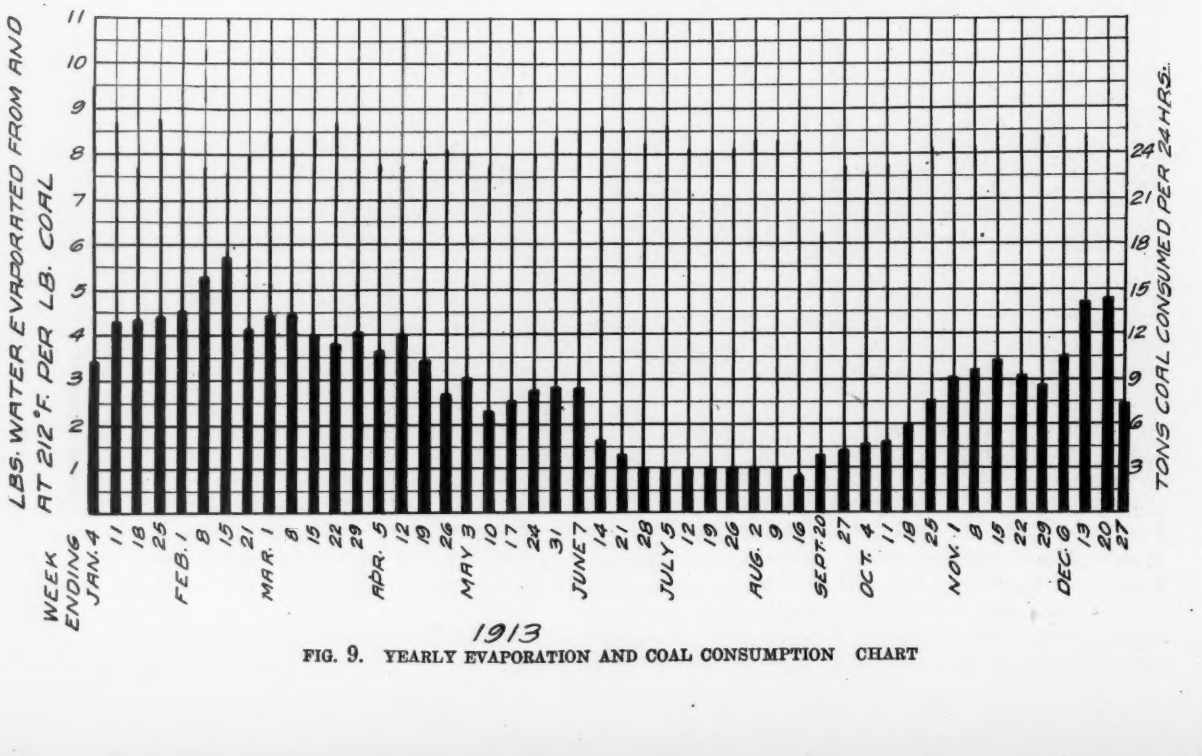

LBS. WATER EVAPORATED FROM AND AT 212 °F. PER LB. COAL
TONS COAL CONSUMED PER 24 HRS.
WEEK ENDING
JAN. 4 11 18 25
FEB. 1 8 15 21
MAR. 1 8 15 22 29
APR. 5 12 19 26
MAY 3 10 17 24 31
JUNE 7 14 21 28
JULY 5 12 19 26
AUG. 2 9 16
SEPT. 20 27
OCT. 4 11 19 25
NOV. 1 8 15 22 29
DEC. 6 13 20 27
1913

FIG. 9. YEARLY EVAPORATION AND COAL CONSUMPTION CHART

2 coals was made by summing up the coal consumption of the power plant for the months of October, November, December, January and February, 1913-14, during which time the Logan nut and slack was used. The average number of pounds of water evaporated from and at 212 deg. F. per pound of coal burned was then found for the 2 periods.

From the information thus obtained and based upon the above-mentioned prices, it was determined that for each ton of Logan nut and slack burned, 16,760 lb. of water were evaporated, while for each ton of New River nut and slack burned, 18,560 lb. of water were evaporated. Or, on a financial basis, the number of pounds of water evaporated for each dollar's worth of coal burned was found to be 7050 lb. for Logan nut and slack, and 6750 lb. for New River nut and slack, an excess of 300 lb. in favor of the former.

Estimating a year's supply of the Logan fuel at $6000, a fair average, the cost of New River nut and slack for the same period would be $6270, or an excess of $270.

Relative to the reduction in furnace repairs due to the use of this new coal, the report of the test reads as follows: "Furnace repairs were obviously greatly decreased by the use of the New River nut and slack, and while insufficient time has elapsed since the use of this coal was begun to differentiate between cost of repairs due to the 2 coals, nevertheless the chief engineer of the power plant and others intimately acquainted with the situation estimate the decrease in repair costs to be at least 50 per cent. With an average repairs to equipment of $750 a yr. with the Logan nut and slack, the saving effected by the use of the New River coal would be at least $375, which more than counterbalances the loss due to increased cost of evaporation. In addition, the New River nut and slack being a smokeless coal, is much cleaner and easier to handle than the other."

This plant, which is now in charge of Edward Bittner, chief engineer, was designed and built by Walter G. Franz, consulting engineer, Cincinnati, O. Professor J. T. Faig, to whom we are indebted for the privilege of visiting the plant and obtaining the necessary information by which this article has become possible, is official head of the Mechanical Engineering Department of the University of Cincinnati.

Virginia Power Co. Coal and Ash Tower

DOUBLE-SKIP HOISTING SYSTEM CRUSHES AND DISTRIBUTES 150 TONS OF COAL AN HOUR. BY WALTER PAINTER

COAL, for the present installation of 12 600-hp. Rust boilers and a future installation of equal capacity at the Cabin Creek, W. Va., station of the Virginia Power Co., is handled by a double-skip hoisting system which operates in a structural steel tower 124 ft. in height.

In this structure is a concrete-lined coal hopper, crushing rolls, machinery for operating the 2 1-ton skip hoists, and a concrete lined ash hopper. Placed in the ground at the bottom of the tower are 2 concrete receiving hoppers, one for coal and the other for ashes, as shown in Fig. 2.

Coal arriving at the station is discharged from the cars into the receiving coal hopper. One of the elevating skips is then lowered to a point below the discharge spout of the hopper so that coal runs into it by gravity, the flow being controlled by an S-gate operated by a lever at the operator's platform. Before the gate opens, however, a movable chute is moved out by the same operation so that no coal is dropped into the skip when the gate is being opened or closed.

When filled with coal the skip is hoisted by a 50-hp. motor drive to the top of the tower where it automatically dumps its contents into a double set of crushing rolls which are operated by 2 15-hp. induction motors running at 850 r.p.m.

From the crushers the coal is discharged into 2-ton cable-operated cars which, after the weight is recorded, convey it to the boiler room hoppers. Each car has a cable grip which is tightened by a setscrew on an endless cable that runs around guide pulleys at the track curves and on rolls on straight runs, from the tower to the boiler house on the left and crossing over, returns through the boiler house on the right. The 2 boiler houses and the coal tower are shown in Fig. 1.

Placed at any desired point along the track over the hoppers, is a tripper which automatically dumps the car load. When the car returns to the tower, a pull of a lever resets the side doors and the car is ready for a new load.

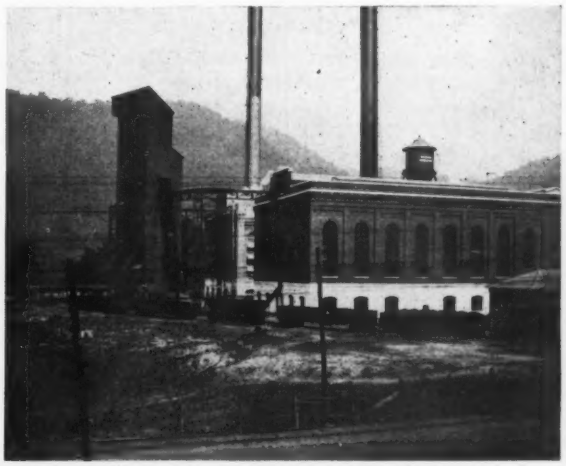


FIG. 1. COAL TOWER AT CABIN CREEK JUNCTION, W. VA., STATION OF VIRGINIA POWER CO.

For hoisting, crushing and conveying coal, this tower has a maximum capacity of 150 tons an hour.

ASHES

FINE COAL and ashes are brought out from the cinder room in small industrial cars, the fine coal being dumped into the concrete receiving hopper, and, mixing with the other coal, reaches the boiler hoppers as previously

described. Ashes are dumped into the ash hopper and, after being elevated by the skips, are discharged into a vertical chute and enter a 250-ton ash bin, from which they are discharged by gravity into the empty cars.

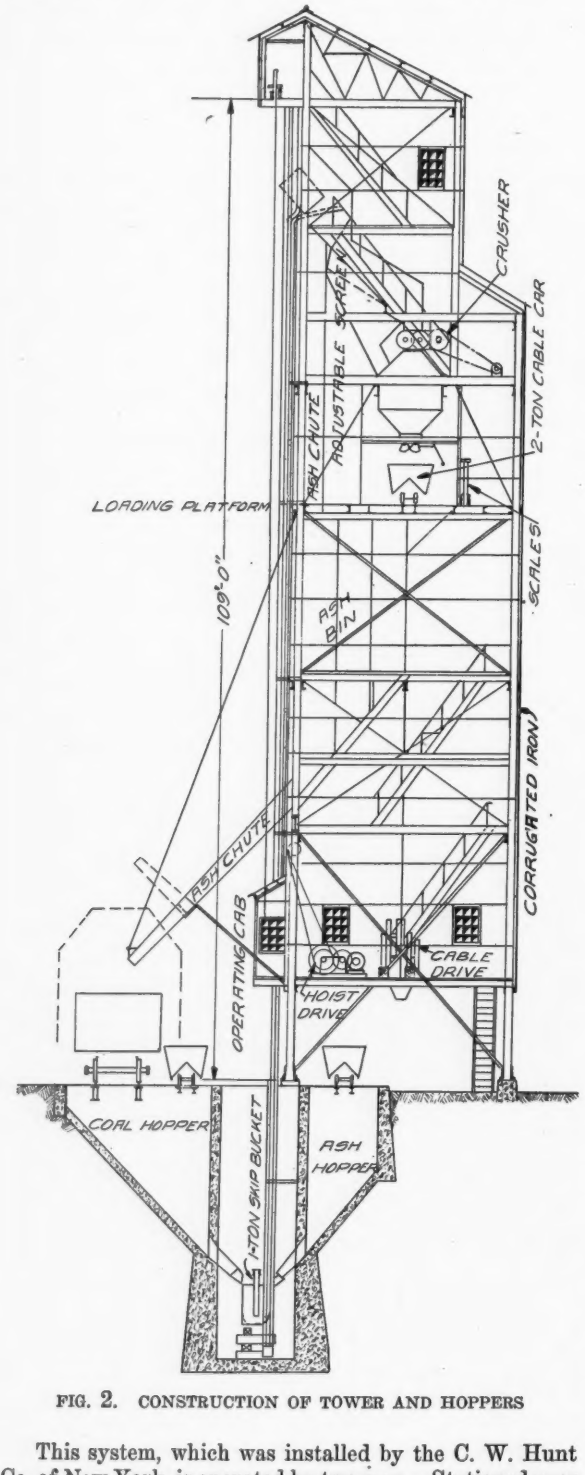


FIG. 2. CONSTRUCTION OF TOWER AND HOPPERS

This system, which was installed by the C. W. Hunt Co. of New York, is operated by two men. Stationed near the bottom of the tower, one man operates the hoists; the other man, on the loading platform, operates the crushers, fills the cable cars and records the coal weights.

Spun Glass as Pipe Covering

SUCCESSFUL experiments have recently been made in Germany with spun glass as an insulating material to retain the heat in steam pipes. Many advantages are claimed for it. In the first place, it adds less to the weight of the pipes than other insulating materials, since it is considerably lighter even than cork. Moreover, it is insensitive to the vibration of the pipes, and is not affected either by high temperatures or by the action of water, steam, or acids. Its structure is not altered even by long lapses of time, and since it does not break and crumble it retains its pristine insulating power. Likewise it can be used a second time, because of this lack of deterioration.

The technique of installation is thus described in the *Mitteilungen uber Genstande des Artillerie- und Geniewesens* (Notes on Artillery and Engineering Matters):

"It is advisable to place rings of asbestos at intervals around the pipes, and between the rings the spun glass is wound loosely around the pipes. The whole is then enclosed in asbestos braid and sailcloth and painted with tar or oil-paint, preferably the latter.

"The spun glass consists of extremely fine glass threads, from 0.03 to 0.05 millimeters in diameter, and forms loose, porous wadding. The admirable insulating capacity of this material is due to the air held in these interstices, and is increased by the fact that the mirror-like surfaces of the glass constantly reflect the heat."—Valve World.

RECLAMATION of swamp land is one of the recent activities that has large possibilities and far-reaching results. There are some 75,000,000 acres that can be put to useful service by this method, and, naturally, will be among the most fertile of our agricultural land. While the larger part is in the southern tier of states, over 5,800,000 acres is available in Minnesota, 2,900,000 acres in Michigan, 529,000 in New York, and even such mountainous states as Pennsylvania and Vermont have 50,000 and 23,000 acres, respectively. Altogether, the area reclaimable is equal to 72 per cent of that now planted to corn and twice that used in raising cotton.

As swamps, the land is of no value,—is even a menace as a fever breeder, while at an expense of $12 to $25 an acre for clearing,—repaid in most cases by the value of the lumber,—and of $3 to $7 for draining, the land becomes valuable, ranging in price from $50 an acre upward. The cost is paid by direct taxes for the initial expense and by bond issues for the main charges and upkeep, the bonds running from 20 to 40 yr.

In some districts, gravity drainage can be secured by ditches, in others levees and pumping works must be employed. In all cases, valuable additions are made to the food producing resources of the country and breeding holes for the disease bearing mosquito are destroyed. The projects as outlined by the Chamber of Commerce of the United States are among our best conservation enterprises, and are a valuable contribution of the engineering profession to the welfare of our country.

PLANS ARE under way to enlarge the power plant of the DeKalb-Sycamore Electric Co., at DeKalb, Ill.

Indicators---II

DETAILED DESCRIPTIONS OF VARIOUS MAKES OF INDICATORS

IN the Nov. 1 issue a general treatment of the subject of indicators was given, also description of the principal types of reducing motions. Continuing the subject, we will consider the details of construction and operation of the principal makes of commercial instruments.

THE AMERICAN-THOMPSON IMPROVED INDICATOR

AMERICAN-THOMPSON Improved Indicators, are furnished with enclosed exposed-springs and for ordinary steam engine, locomotive, gas and oil engine, hydraulic and ammonia service.

In this indicator, shown in Figs. 9 and 10, and which is of the enclosed spring type for ordinary steam-engine service, the cylinder is made of a special hard bronze composition differing slightly from that used in the piston head. It is held securely at one end and is of such external diameter as to provide sufficient space between it and the cylinder sleeve to form a suitable steam jacket.

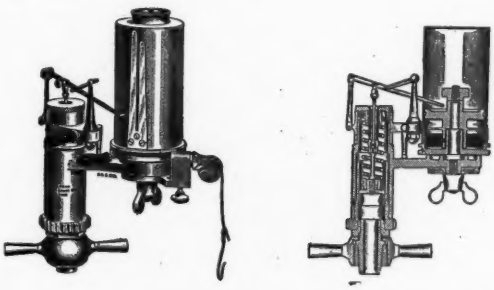


FIG. 9. OUTSIDE VIEW OF AMERICAN-THOMPSON IMPROVED INDICATOR

FIG. 10. SECTIONAL VIEW OF AMERICAN-THOMPSON IMPROVED INDICATOR

The piston, which is grooved for water packing, is connected by means of a steel stem with the pencil lever by a connecting rod having a crosshead at the upper end and held in place by means of a small hexagonal lock nut. The top of the connecting rod being threaded permits raising and lowering the crosshead and forms a means of adjusting the position of the atmospheric line on the diagram. Such adjustment is, however, not necessary except when special springs are employed. A socket at the lower end of the connecting rod rests on the ball stud, which is adjustable in the piston stem, thus giving a perfect ball and socket joint.

The pencil movement has a ratio of 3 to 1 and is guided by a short connecting link fastened to the stationary arm or post of the parallel motion and is connected to the piston rod by a yoke and screw.

Movement of the paper cylinder is so designed that the tension of the coiled drum spring within the cylinder can be increased or decreased for various engine speeds. For high-speed work, no special adjustments are necessary, except to give sufficient tension to the drum spring to keep the cord taut at all times.

All springs employed are made of steel wire wound on a mandrel with from 4 to 4½ turns per inch, and are scaled providing for vacuum. Special vacuum springs of regular thread and scaled for vacuum only may, nowever, be obtained if desired.

A distinctive feature of these instruments is the new improved detent motion making it possible to take 4 cards a minute without stopping or disconnecting the drum cord from the drum carriage. In order to stop the paper drum, it is only necessary to move lever A, Fig. 11, in the direction traveled by the drum until it releases itself. The lever must then be returned to its original position. When ready to take a diagram, turn the paper drum by means of the milled rim B on top forward until it catches, causing the drum to revolve in the usual manner; then take the diagram and release the drum as described above.

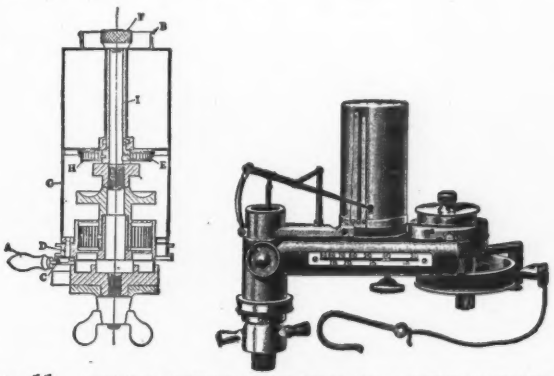


FIG. 11. DETENT MOTION EMPLOYED ON AMERICAN-THOMPSON IMPROVED INDICATOR

FIG. 12. OUTSIDE VIEW, BACHELDER INDICATOR

The standard size of piston employed is ¼ sq. in. in area, although if so desired, an extra piston and steam cylinder of ½ sq. in. area may be had.

BACHELDER INDICATOR

CHARACTERISTICS of this instrument, Fig. 12, are the hollow T-shaped case and adjustable flat spring contained therein. The cylinder is screwed into the lower end of the case and held by a small set screw, requiring a half turn to permit being unscrewed. The flat spring works in the horizontal body of the case, one end being secured rigidly by means of a taper screw and the other attached to the connecting rod between the piston and pencil arm. To remove the spring, it is only necessary to remove the screw connecting it to the piston rod and the one which holds it in the case. So great is the range of the high-pressure spring that no change is necessary except when using the instrument on a compound or triple-expansion engine. Connection is made to the piston with a ball and socket joint and access may be had to the piston for oiling or removing, by unscrewing the knurled cap on the face of the instrument.

The flat spring extends through a recess in a split bushing in the upper side of which is inserted a hard-

ened steel pin, against which the spring is held rigidly by a set screw passing up through the lower side of the bushing. By loosening the set screw and sliding the bushing along until the mark on the projecting block is opposite the scale required, it is possible to vary the scale of the spring as desired. The upper scale, marked on the face of the case, is for high pressure, while the lower one is for low pressure. With these 2 springs, it is possible to indicate over a range of pressures from 10 to 200 lb.

Freedom from lost motion and friction makes the parallel motion entirely accurate. By means of a swivel in the connecting rod near the pencil lever, it is possible to adjust the height of the pencil point as desired. Since downward motion of the spring is the same as upward, a correct diagram is given from the condensing or low-pressure cylinder of a compound engine. These indicators are now fitted with a simple form of detent

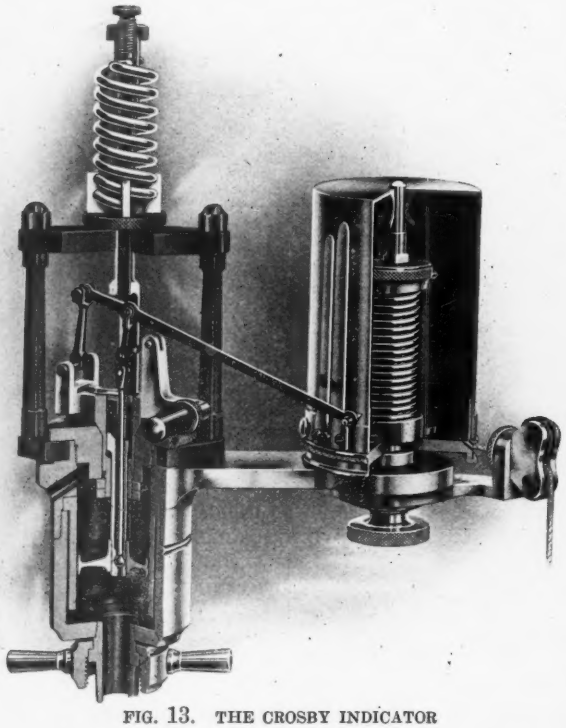


FIG. 13. THE CROSBY INDICATOR

motion, enabling the operator to change cards without unhooking the indicator cord. It will be noted that this is really an outside spring with the additional advantage of being partly encased so as to protect it from outside variations of temperature. The piston is of the ordinary type, grooved for water packing against leakage.

CROSBY INDICATOR

AS ILLUSTRATED, this instrument is designed for an outside spring, thus removing the error generally arising from the action of heat on the spring and making the changing of springs an easy matter.

The piston, which has an area of 1 sq. in., is in form the central zone of a sphere, thus affording great active force with an exceedingly light pencil mechanism. It is attached by a rod directly to the upper end of the spring and moves freely, regardless of any eccentricity in the spring. Line contact of the piston with the interior of the cylinder reduces friction to a minimum.

By means of a ball and socket joint, the pencil mechanism is connected with a rod to and directly over the piston. This rod slides through a sleeve attached to the base of the pencil mechanism, and, moving in a vertical line, compels the pencil also to move in a vertical line. Thus, any motion of the piston due to the movement of the spring which might cause the spring rod to deviate, will not affect the pencil mechanism in its vertical course.

Of unique design and construction is the piston spring, which is made of a single piece of fine spring steel wire, wound from the middle into a double coil, the spiral ends of which are screwed into a brass head having 4 radial wings. Adjustment is made by screwing them into the heads until the proper strength of spring is obtained, when they are firmly fixed.

In addition to the large piston, a smaller one of ½ sq. in. area is furnished for use with gas engines.

By adjusting the pencil, the diagram may be located in any desired position on the drum, simply by loosening the binding nut below the spring, and screwing the

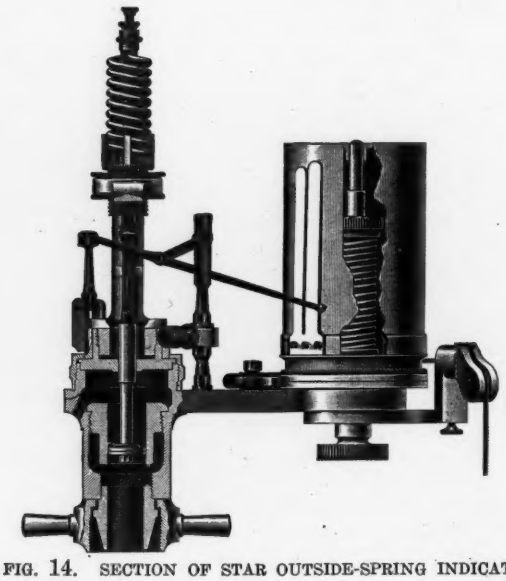


FIG. 14. SECTION OF STAR OUTSIDE-SPRING INDICATOR

spring upward or downward, carrying with it the entire pencil mechanism. For taking a series of diagrams, a special drum is used upon which a roll of paper is wound in such a way that a diagram may be taken for each revolution of the engine.

STAR INDICATOR

IN FIG. 14 is shown a sectional view of the outside spring type of indicator, in which the spring is readily accessible for quick changes when the instrument is hot, and at the same time free from the ill effects of high temperatures. Thompson's parallel movement has been adapted in this construction, insuring straightline motion of the pencil at all points of the stroke.

The spring is wound into a double coil from a single piece of steel wire, the 2 ends being attached to a bronze

head which is securely screwed down against the framework above the cylinder. At the upper end of the spring there is no metal except a small spherical ball which is firmly attached to the spring and furnishes a ball and socket joint between the spring and piston.

At the upper end of the piston rod is a slot through which the ball passes and a knurled screw which secures the ball in its bearing. The piston rod is also hollow and is slotted for the pencil bar and connecting link. Adjustment of the height of the atmospheric line is made by turning the knurled washers below the spring.

With the small piston, which has an area of ¼ sq. in., and is very narrow, weight and friction are reduced to a minimum, permitting the use of a light spring which makes the instrument both sensitive and accurate. Owing to the light construction of the moving parts, the error resulting from inertia is also minimized.

Tabor Indicators

Parallel motion in this indicator is accomplished by means of a stationary guide plate containing mathematically plotted curved slot, Fig. 15, which is engaged by a roller bearing fastened to the pencil bar by a small pin. This produces a straight-line motion of the pencil, the length of which is limited only by the requirements of service and the size of the mechanism. At the same

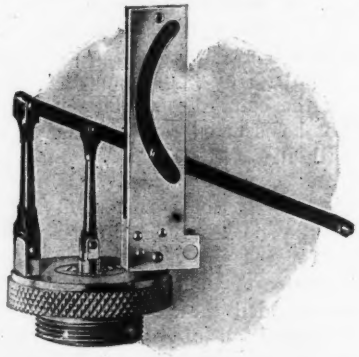


FIG. 15. PARALLEL MOTION MECHANISM, TABOR INDICATOR

time the ratio of the pencil movement to the lineal displacement of the piston is maintained constant throughout the entire stroke. Another advantage claimed for this style of pencil motion is that with the high drum, made possible by the long straight-line pencil motion, the atmospheric line is automatically regulated eliminating the human element to a great extent in taking cards, as well as doing away with a certain number of parts with their consequent wear and lost motion.

Pressure springs used with the Tabor Indicator are of the duplex type, made of 2 coils of wire attached diametrically opposite each other on the end bases. The effect of such an arrangement is to give an even distribution of the stress between the 2 coils, and the pitch of the coils being the same from end to end to distribute this stress evenly throughout the entire coil. In addition, the piston is held in a vertical position at all times and the tendency to cock and bind against the cylinder walls is eliminated. Different lengths of springs are used for different pressures the length of spring decreasing as the pressure increases, thus automatically locating the atmosphere line as previously mentioned.

In the type of instrument shown in Fig. 16, the outside spring is used removing it from the effects of the heat and permitting quick change of springs.

The piston is so designed as to have the effect of 4 short pistons separated by deep grooves. These grooves tend to trap and store any substances which may find their way to the indicator and as a very efficient steam packing effect is given, slightly greater clearance may be allowed, permitting any dirt which is not trapped in the piston to find its way to the exhaust without

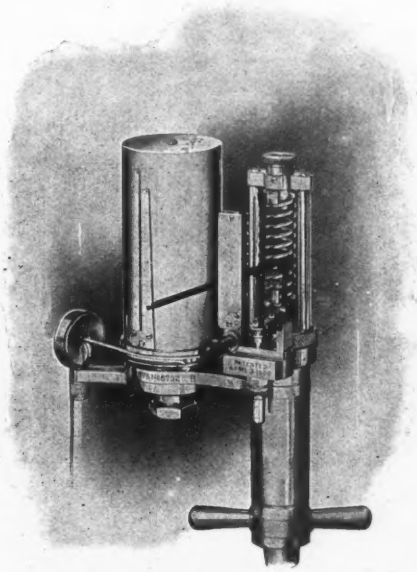


FIG. 16. THE TABOR INDICATOR

affecting the inside portions of the mechanism. The pistons are ordinarily provided in ½ sq. in. area for steam indication and in ¼ sq. in. area in connection with hydraulic and gas engine work.

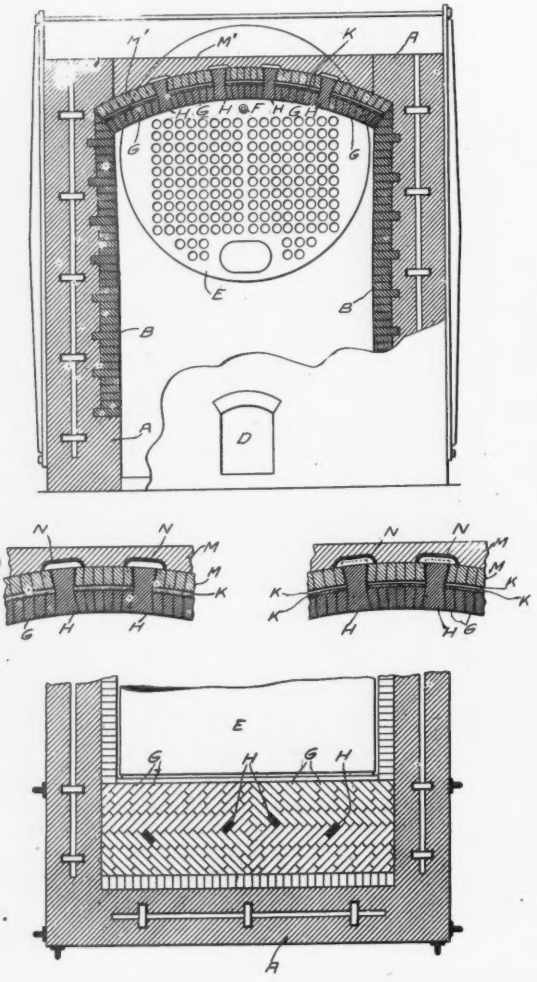
Tabor Indicators are produced for steam, gas engine, steam and gas engine and ammonia service, although these types are often adapted to other purposes. They are furnished if desired with enclosed springs and may be obtained with or without electrically operated pencil attachment. (To be continued.)

In the article on Patching Concrete Floors, published in the August 1 issue of Practical Engineer, the devisors of this method neglected to state that the method, which consists of a mixture of asbestos fiber and rubber gum, is not applicable to the repair of deep holes or large areas. This system of patching is quickly accomplished and gives good results for patches about ⅛ in. thick, and where the truck loads do not exceed 1½ tons, but for deep holes or large areas they will not stand up. For such patching, apparently the only method is to cut out a square edged hole in the concrete and refill with new concrete, using the same care as in laying a new floor.

Germantown, Ill., is making plans for a city electric light plant, the matter being in the hands of V. J. Kluthe, architect, 915 Olive St., St. Louis, Mo.

Novel Arch Construction

FOR rear combustion arches in return tubular boilers, Louis Bernhard, of Boston, has devised a special construction which has been installed in several hundred New England textile mills. The arch is double, the 2 parts being joined by wedge blocks, which permit of upper and downward movement of the lower arch, due to expansion and contraction, but hold the arch from falling and wedge it fast when it contracts from cooling.



DETAILS OF CONSTRUCTION OF THE BERNHARD REAR ARCH

The upper arch is made of common brick resting on the side walls as butments, and is covered on top with a layer of common brick to form a part of the boiler roof. The lower arch is of fire brick, also butting on the fire brick of the side walls, and is laid in place first, with the wedge connectors, which are of hour-glass shape, projecting upward. A layer of magnesia is then placed on top of the lower arch, and the upper arch brick laid on this, being set close around the connectors so as to hold them in place. Above the upper ends of the connectors, cover caps are placed to permit these ends to rise as the lower fire-brick arch expands when heated. When the arch is heated, the magnesia contracts, leaving an air space which permits of the come and go of the lower arch, and also assists in preventing radiation of heat from the lower arch to the upper one. The binders between the 2 arches are of firebrick and serve to prevent lateral motion of the lower arch as well as taking the weight when the lower arch contracts, and producing the wedge action to tighten up the lower arch. As seen from the plan view, the bricks in the arch are laid diagonal to prevent direct pressure against the side walls, the tendency being to produce a cornerwise pressure bearing against the rear wall and the head of the boiler.

OF LATE YEARS there has been tendency in many technical schools and colleges to adopt the half-time system of instruction, in which the students are alternate weeks or months in the school room and in the shop. A variation in this is now being tried at Bristol University, England, in which the student who has made a good record for the first term in the University is recommended for 14 months' training in some affiliated engineering works, to give him an insight into the practical side of engineering and let him find out whether he is really fitted for such work. If he makes a successful record in the work, he is then returned to the University for 2 yr., also putting in time in the works during the long vacation. He then returns for another 14 months in the factory to complete his University course. In this way, he gets about 2½ yr. in the shop and 2½ yr. in the University, thus giving practically a half-time course, 5 yr. in length, but having the added advantage of giving sufficient time in the shop, early in the course, to enable him to determine whether or not he is fitted for engineering and wishes to keep on with it.

IN CONNECTION WITH the movement for advancing the hands of the clock an hour during the summer months, in order to take advantage of the daylight period, a committee of the American Railway Association has recommended that, in view of the fact that the present subdivision of time is scientifically correct, and that any change, unless made simultaneously all over the country, would result in much confusion, the railroads, while not antagonizing the movement, should not adopt it until it has been previously adopted by the principal business and municipal centers, as well as state and local authorities.

This action is based on the fact that previous to the adoption of standard time, there was endless confusion in regard to railroad time tables throughout the country, which has now been cleared away, and it is felt by the railroads that, unless unanimous action can be secured so that during the 6 summer months the advanced time schedule shall be adopted throughout the country, a partial return to the former confusing conditions would exist. Opinions from the European countries where the daylight saving system has been enforced during the past summer, are favorable to the adoption of this practice as a regular thing in the future, and it is to be hoped that it can be brought into operation in this country; but the stand of the railroads is reasonable, as the confusion from adoption of the daylight saving method in part of the country and maintaining the present time schedule in other parts, would result in much misunderstanding and difficulty in the operation of trains.

Station Operation*

Boiler Switchboard for Efficiency Control

ATTEMPT will be made to illustrate a method of efficiently carrying boiler load by means of the indications afforded by a set of switchboard instruments.

Under a condition of varying output the efficiency of the unit is supposed to remain substantially constant. If this could be maintained exactly, the solution to general plant efficiency would be at hand. While it is not possible to live up to theoretical conditions in this respect, these conditions afford us a standard of comparison.

It is not possible to determine continuously the efficiency of the combustion process in the boiler furnace. There are losses due to incomplete combustion of gases and the formation of CO and unburned hydrocarbons; there are losses due to the infiltration of air both through the fuel bed and the boiler walls, and there are the losses due to the ash pit.

The gas analysis recorder affords probably the best means for indicating in a substantially continuous manner the condition of the flue gases, but unfortunately good CO_2 can be developed at the expense of the ash pit. It is easy to offset all of the advantages of good CO_2 by carrying too heavy a fire, and thereby throwing away a lot of combustible.

Any direct indication of furnace efficiency must include the ashpit loss, and it is not possible to make any instrument that will clearly indicate over all efficiency under all variations of rating, fuel quality, type of boiler, type of stoker, and the personal equation. It may be safely stated that no boiler installations are the same, and each one must have its own peculiar conditions.

The committee has been earnestly striving to work out a practical operating method, by which the plant engineer can gage the combustion efficiency, and keep tab on the firemen; the instruments by means of which this object is to be accomplished are briefly as follows:

Boiler Control Board

In the boiler room directly in front of the stoker, standing against the opposite wall, is the individual panel or gage board, on which the instruments belonging to the particular boiler are placed. Beginning at the top, the integrating meter is a part of the steam flow metering equipment built by the Republic Flow Meters Co., and shows the total number of pounds of steam produced by the boiler. This is designed to be read daily, so that the total steam output can be checked against the total coal consumption.

At the upper left hand is the Republic Steam Flow Indicator, showing the momentary output of the boiler, for the use of firemen in judging the momentary condition of the boiler, and to observe the effect of changes in the draft or stoker speed. The pointer responds to every change in header pressure, and rate of feeding the boiler.

Most interesting results are observed in the effect of opening the feed valve. A boiler steaming at 1000 hp. can be checked down to 300 or 400 hp. for a short time, by opening the feed valve. It is not generally appreciated how sensitive a boiler is to this influence, and it is astonishing to see what happens when you suddenly open up the water supply.

The upper right hand instrument is the recorder of a thermometer placed in the boiler breeching connection. This thermometer indicates continuously the temperature of the flue gases and clearly also the effect of excess air and gas volume. An increase of 50 per cent in the flue temperature can be made by simply decreasing the

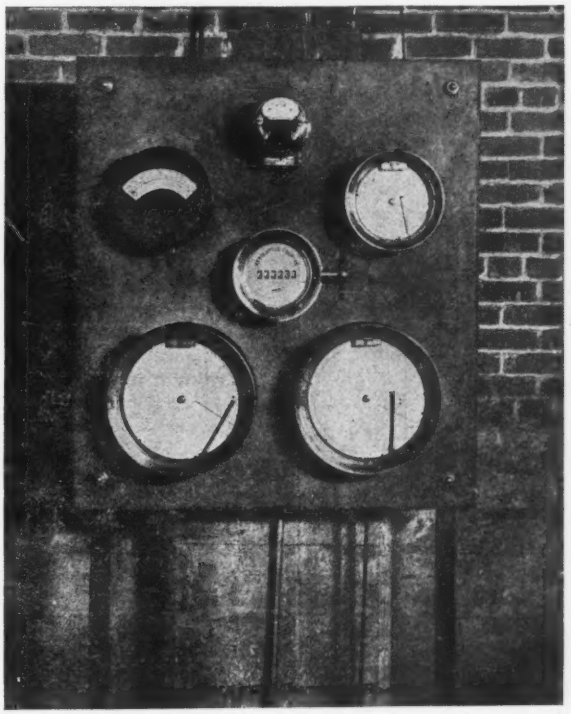


FIG. 1. ARRANGEMENT OF BOILER CONTROL BOARD

CO_2 2 or 3 per cent. This effect is not generally considered when the desirability of increasing CO_2 is discussed, yet under the conditions obtaining at the plant being described, each 100 deg. rise in flue temperature accounted for approximately 3 per cent of the coal fired. Moreover, this thermometer indicates the condition of cleanness of the flues. It is of great value in indicating the boiler efficiency and when the proper conditions are established, and the lowest practical flue temperature once determined, serves as a constant indication whether things are as they should be.

In the middle of the panel is the revolution counter, which is attached to the main drive shaft of the stoker, and indicates the number of times the plungers operate. In a stoker of this particular type it is useful in showing uniformity of stoker operation and, as ratios are estab-

*From the Report of the Station Operating Committee, National District Heating Ass'n.

lished gives the engineer a check on the coal consumption. Inasmuch as the displacement per stroke is nearly constant, a close idea of coal consumption for short periods can be obtained by the indications of the revolution counter.

At the lower right hand corner is a large Foxboro Recording draft gage, equipped with 2 pens, the one near the outside of the chart indicating the pressure above atmosphere in the wind box of the stoker, and that nearer the center of the chart indicating the draft or vacuum in the furnace. As the boiler was out of commission when the photograph was taken, these 2 pens stand close together at the zero line. The range is 6 in. of water pressure and 0.5 in. of water vacuum. These indications show not only what the actual conditions are, but the distance between the 2 pens indicates closely

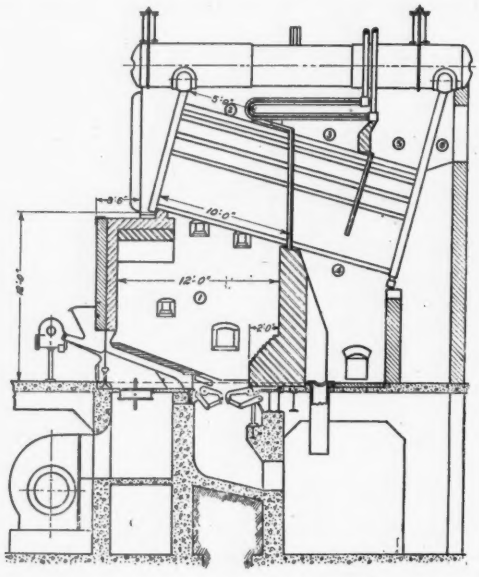


FIG. 2. SECTIONAL VIEW OF BOILER TESTED, SHOWING POINTS WHERE TEMPERATURE WAS MEASURED

the condition of the fuel bed. If the fuel bed is thin or has a hole in it, its resistance will decrease, the draft in the furnace will go down, and the distance between the 2 pens will decrease. With other conditions constant this can be closely checked against the amount of air per pound of coal, or the CO_2 by analysis.

In order, however, to afford a more continuous and simple check the lower left-hand gage is employed. This is a similar instrument, except that it shows vacuum with both pens, the one nearer the outside shows the vacuum in the furnace, and the other shows the vacuum just inside the boiler damper. This is a direct indication of the loss in the boiler, consequently is a direct measure of the volume of gases passing through the setting.

Furnace gas volume may be increased in 2 ways; first, by increasing the rate of combustion, hence the number of pounds of air required per unit of time; and second, by the infiltration of excess air throughout the fuel bed, furnace door, or other openings. The amount of draft loss in the *boiler,* therefore, does not indicate anything about the quality of the gases, but is only an indication of the quantity. Other conditions must therefore be considered in order to determine whether an increased boiler resistance is an indication of efficiency, or capacity.

If the gas volume is great, as indicated in the boiler resistance gage, it *should* mean a high rate of combustion. To obtain a high rate of combustion with the minimum weight of air per pound of coal, a high fuel bed resistance is necessary, and the pens of this instrument also must stand far apart. With this indication of high capacity is the indication of the flow meter, which proves conclusively that the boiler is actually steaming as indicated by the resistance above described.

When a condition like this is established, a definite gas temperature should be obtained, and it soon becomes easy to determine whether or not the boiler is getting dirty, or the baffles getting leaky, by means of the recorded flue temperature.

Suppose the conditions change, and the operator allows his grate surface to become bare; what will be

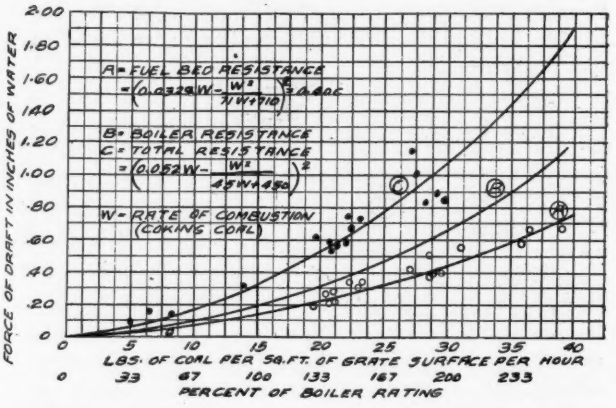


FIG. 3. CURVES OF DRAFT RESISTANCE AND BOILER OUTPUT

the indications thereof? On account of the wind pressure not having been intentionally reduced, the decreased fuel bed resistance will have a tendency to bring the furnace draft down towards zero. The 2 pens of the lower right-hand instrument will draw together, and there will be a large volume of excess air passing through the fuel bed, and into the furnace. This will result in an unusually large volume of gases for the boiler to take care of, and the resistance will therefore increase, and the 2 pens of the other draft gage will separate. In this particular installation where the recording flow meter is in use, the result will be instantly shown in decreased steam output. Moreover, if the excess air is not too great the flue temperature will go up, and there will be a loss due both to excess air, and improper absorption of heat.

Assume the reverse of the preceding. The fuel bed is allowed to become unduly heavy and great resistance is offered to the flow of air through it. The vacuum in the furnace therefore increases and the fuel bed pens separate. The resultant small volume of gas goes through the boiler with but slight difficulty and the boiler pens approach. This indicates low capacity and too much CO_2.

The plant selected for this research consisted of a Babcock & Wilcox boiler, 18 tubes wide and 14 high, rated at 512 hp., and equipped with a Babcock & Wilcox

superheater and Westinghouse stoker. It was set high to give ample combustion space. The sectional elevation is shown in Fig. 2. Points are shown where draft and temperature readings were taken.

Draft Indications of Efficiency

That there is a definite relation between the draft indications and the efficiency of the unit is established. The time available since the first operation of the plant just described, did not permit of working out the curves as completely as desired, and we therefore illustrate, Fig. 3, the principle by curves developed at another plant, wherein the boiler was similar, although the stoker was different. These are curves of constant CO_2, this being around 12 per cent at the damper of the boiler. The drafts in this case were plotted against the pounds of coal per square foot of grate surface, and the rating of the boiler. Points are quite well defined, and the curves of such a nature that it is possible to develop an equation from them.

Curve A is the fuel bed resistance, that is the difference between pressures above and below the fuel bed. Curve B is the boiler resistance, being the difference between the furnace, and the damper drafts, and C is the total resistance, being the sum of the other 2. It is quite evident from this that, if it was desired to get double rating from this unit, 30 lb. of coal per square foot of grate surface per hour would be required, with a total draft loss of 1.10 in. If it were a natural draft installation throughout, this would mean that the draft inside the damper would have to be 1.10 in. and the draft over the fire 0.45 in.

In the case of a forced blast installation, the double pen record would be called into play, and the difference between the pen indications utilized to determine the same conditions of resistance. Under these conditions it would be known that the gases at the damper would analyze 12 per cent of CO_2.

Should it be desired to operate this boiler at its rating, all that would be required would be to drop the damper draft to 0.32 in. and the furnace draft to 0.14 in. in the case of a natural draft installation, and the result would be obtained.

In how many cases, under ordinary operating conditions would it be possible to alter the rate of steaming 100 per cent, with any assurance that efficient conditions would be obtained, unless rather elaborate analyses were taken at frequent intervals. By this method the simple indications of the draft gage are all that are required.

Side Wall Construction

A new theory of side wall construction is here suggested, designed to: (1) Stop the loss due to air infiltration. (2) Stop the loss due to heat radiation. (3) Stop the cracking of brick work. (4) Make furnace repairs easy.

From infiltration, in the best of settings the drop in CO_2 between the furnace and the damper is about 2 per cent, and in a setting which is old and cracked this drop may amount to 5 or 6 per cent. In extreme cases it has been shown that as much air entered the setting through the walls and poorly fitting doors as through the fuel bed. The injury is increased when the leakage occurs at the furnace, because the entire heating surface then has to be passed over.

On account of the much higher temperature in the furnace, radiation loss from this region becomes excessive, and if any part of the setting is to be insulated it should be that part opposite to the high temperature zone. Acting on the above reasoning the research installation was designed with the outside furnace walls protected against both infiltration and radiation.

Another and serious trouble with brick settings, is the cracking of side walls, which almost invariably occurs, especially in high settings. Brick work is not elastic, and lines of fracture occur when one portion is heated to excess. There is a sharp drop in temperature after the first tubes are reached, and on account of the closeness of the side walls to the tubes, the walls here do not get nearly as hot as in the furnace. The expansion of the front end of the setting is therefore due almost entirely to the high temperature of the furnace, and if the strains in the brick work due to this cause could be removed the rest of the setting would expand with reasonable uniformity.

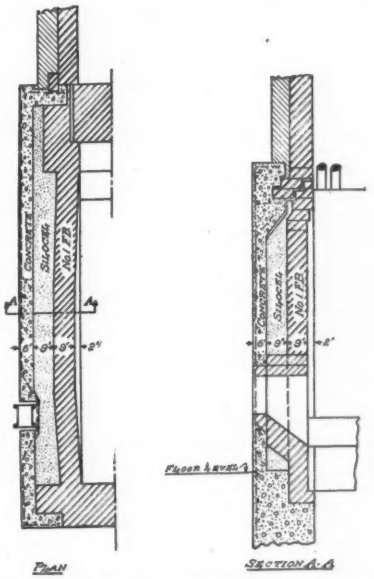


FIG. 4. DETAILS OF IMPROVED BOILER SIDEWALL CONSTRUCTION

To accomplish all of these things, the design, Fig. 4, was adopted. The outside wall is of reinforced concrete, so designed that the brick work of the setting above the bottom row of tubes is carried entirely on it. To prevent the concrete from getting overheated, a layer of silocel insulating brick is placed next, and the wall finished off with the usual 9-in. fire brick lining. This lining is built substantially independent of the rest of the brick work, expansion space being provided at the top so that the wall can come and go without putting any strain on the surrounding parts, or on itself.

To prevent the tendency to fall into the furnace, the wall is built slightly concave or arched outward in plan view. None of the weight of the setting is carried on this wall so that there is no tendency for it to crush and settle when heated. It can be compared to the independent fire brick lining placed in concrete chimneys.

Electrical Machinery and Appliances

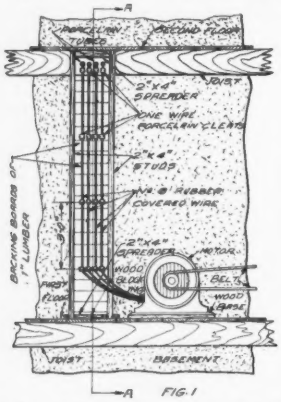
For Generating, Transmitting and Using Current

Wiring for Motor Additions

READILY CONSTRUCTED RUNWAY PROTECTS AND SUPPORTS LINES SERVING MACHINES. BY CHARLES H. TRAPP

WHEN installing additional motors in industrial plants it is often necessary to locate the machines at some point inconvenient to the service wires.

A suitable method of carrying wires required to be brought down to a motor from the ceiling above is illustrated in Fig. 1. The wire runway consists of 2 2 by 4-in. uprights, extending the entire distance between the floor and the ceiling, and backed with 1-in. strips, Fig. 2, to form a support for the porcelain cleats, as well as protecting the wires against mechanical injury. The uprights are held in place by being nailed to 2 spreaders, one fastened underneath the ceiling and one on top of the floor, as illustrated in Figs. 1 and 2. To secure the uprights further, they should be butted against and nailed to the joist and pieces of 2 by 4-in. blocking nailed to the floor against their outsides.



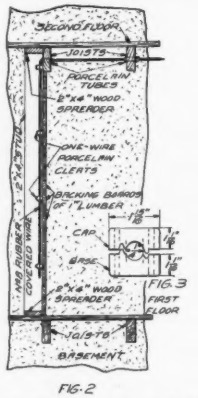


FIG. 1. WIRES SUPPORTED ON ONE-WIRE PORCELAIN CLEATS

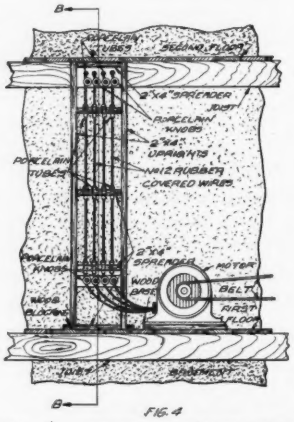
FIG. 2. SECTION A-A, FIG. 1

FIG. 3. SECTION AND DIMENSIONS, STANDARD TYPE OF ONE-WIRE PORCELAIN CLEAT

WIRE SPACINGS FOR VARIOUS VOLTAGES

Voltage	Distance from Supporting Surface	Distance Between Wires
0 to 300	1/2 inch	2-1/2 inch
301 to 550	1 inch	4 inch
550 to 3500	1 inch	8 inch

The wires may be supported either on cleats, Fig. 1, or threaded through porcelain tubes placed in 2 by 4-in. spreaders, as in Fig. 4. When the wires required are of No. 8 B. & S. gage or larger, it is best to support them on one-wire cleats similar to that illustrated in Fig. 3. These cleats may be fastened directly against the backing of the runway as shown in Figs. 1 and 2. Where the wires are of No. 12 B. & S. gage or smaller, it is good practice to run them through porcelain tubes supported in 2 by 4-in. spreaders placed between the uprights, as shown in Figs. 4 and 5. With the construction illustrated in Figs. 4 and 5, all of the wires must be rigidly supported both at the point where they leave the tubes at the ceiling joists and at the lowest spreader. Split porcelain knobs may be used for such supports. At the top they are fastened directly to the face of the joist, while at the bottom they are secured to a special backing strip nailed across the uprights.



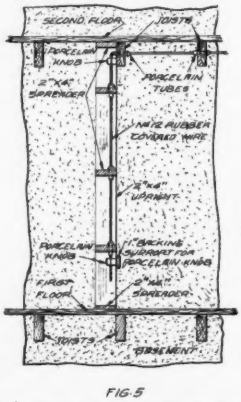


FIG. 4. WIRES THREADED THROUGH PORCELAIN TUBES SUPPORTED IN 2 BY 4-IN. SPREADERS

FIG. 5. SECTION B-B, FIG. 5

The spacing between supports is dependent upon the liability of mechanical injury to the wires. Ordinarily, the supports should not be placed farther apart than 4 ft. 6 in.; but where wires are specially subject to interference or injury, the distance between supports should be shortened.

The spacing between wires and that between the wires and the supporting surface are variables determined by the voltage of the service. The table indicates the proper spacings for various voltages.

DIRECT CURRENT passing through a piece of old moistened blueprint will turn the print white around the negative wire.

Alternating-Current Distribution

DISCUSSION OF RELATIVE ADVANTAGES OF SINGLE-PHASE, 2-PHASE AND 3-PHASE SYSTEMS. BY G. P. ROUX

IN THE early days of the electrical industry single-phase circuits were used for the distribution of alternating current. Later the polyphase system was developed, and almost simultaneously 2-phase and 3-phase motors and generators made their commercial appearance in 1888. At first, the preference was for 2-phase current, the 3-phase system being almost exclusively used for long transmission problems. Since then the 3-phase system has become more popular, and the tendency is now to its exclusive use.

We will, therefore, review and study the question of conductors for each one of the above systems. We will consider each one of the above circuits as having only an ohmic resistance, which is not true, since allowance must be made for capacity, inductance and reactance; but for the sake of simplicity we will treat them as in the case of continuous current, since the impedance in each case for a short line is a factor having almost the same value.

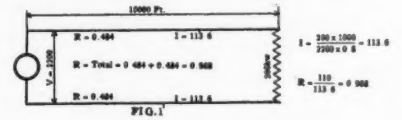


FIG. 1

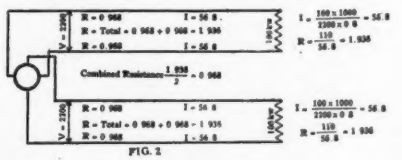


FIG. 2

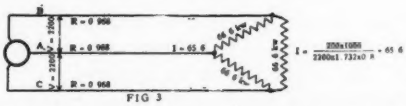


FIG. 3

FIG. 1. SIMPLE SINGLE-PHASE CIRCUIT
FIG. 2. TWO-PHASE 4-WIRE CIRCUIT
FIG. 3. THREE-PHASE 3-WIRE CIRCUIT

Assume, for instance, a case where 200 kw. at 80 per cent power-factor, alternating current is to be transmitted 10,000 ft. with a drop of potential at the receiving end of 5 per cent, the generating voltage being in each case 2200 v., transmission through overhead wires.

In a single-phase system the current in amperes will be equal to the product of 200 times 1000 divided by the product of 2200 times 0.8 or 113.6 amp.

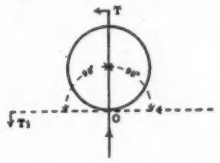
The potential drop being 5 per cent is therefore equal to 2200 times 0.05 or 110 v. The resistance of the conductor is therefore equal to 110 divided by 113.6 or 0.968 ohms.

The circuit, 10,000 ft. long, requires 20,000 ft. of conductor, with a resistance per 1000 ft. of 0.968 divided by 20 or 0.0484 ohms, equivalent to a copper conductor having a cross-section of 209,310 circ. mils, and weighing 635.4 lb. per 1000 ft., or a total weight of 12,708 lb.

In a 2-phase system, the power in each phase being 200 divided by 2 or 100 kw. the current per phase will be equal to the product of 100 times 1000 divided by 2200 times 0.8 or, 56.8 amp., or half that of a single-phase circuit (see Fig. 2). The potential drop will be the same as found above, and therefore the conductor should have a resistance of 110 divided by 56.8, or 1.936 ohms, that is to say, twice the resistance of the single-phase circuit, because the total power is equally divided into 2 circuits in parallel; their individual resistance is therefore twice and their combined resistance the same as that of a single-phase circuit, as shown in Fig. 2.

Here we have 2 circuits in parallel, each 10,000 ft. long, each requiring 20,000 ft. of conductor, or a total of 40,000 ft., and each conductor having a resistance per 1000 ft. of 1.936 divided by 20, or 0.0968 ohms, equivalent to a copper conductor having a cross-section of 104,655 circ. mils and weighing 317.7 lb. per 1000 ft., or a total weight for the 2 circuits or 4 conductors of 12,708 lb.

Considering a 3-phase system, the current in amperes per phase is equal to the product of 200 times 1000 divided by the product of 2200 times 1.732 times 0.8, or 65.6 amp.



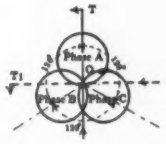


FIG. 4. GRAPHICAL REPRESENTATION OF SINGLE-PHASE CURRENT
FIG. 5. GRAPHICAL REPRESENTATION OF 2-PHASE CURRENT
FIG. 6. GRAPHICAL REPRESENTATION OF 3-PHASE CURRENT

Assuming the same potential drop as in the above cases, 5 per cent, the watts loss in the total lines equals 65.6 times 110 times 1.732, or 12,500, which is the same as obtained in the single-phase and in the 2-phase circuits for the summation of all the I^2R losses or the eI losses, the ohmic voltage drop being in phase with the current. It should be noted that in this article a 5 per cent drop is considered as being equal to a 5 per cent IR rather than a 5 per cent difference between the impressed and receiver voltage. This, then, gives 4167 w. loss per line, and since this equals I^2R, R equals 4167 divided by $(65.6)^2$, or 0.968 ohms as the resistance of each line.

Referring to Figs. 3 and 6, we see that taking the current flowing from *A* at time of maximum instantaneous value shown in position *T* of Fig. 6, it divides at the receiving end into 2 equal currents 120 deg. apart, each having half the value of the current in *A* and flowing back through wires *B* and *C* to the generator. This system can be considered as made up of a circuit consisting of one phase in series with the 2 other phases connected in parallel.

Each branch of the circuit thus requires a conductor having a resistance of 0.968 ohms and, inasmuch as the length is 10,000 ft., the resistance of the conductor per

1000 ft. is 0.968 divided by 10, or 0.0968, equivalent to a copper conductor having a cross-section of 104,655 circ. mils and weighing 317.7 lb. per 1000 ft., or a total weight for the 3 phases of 9531 lb., or 75 per cent of the copper required for either single or 2-phase circuits.

If we consider the 3-phase system for each instantaneous value of current in each phase, we see, by reference to Figs. 3 and 6, that the current in each phase flows from the generator in one direction during half a period, or 180 deg., and passes through all instantaneous values of the sine wave from zero to maximum

SUMMARY OF CALCULATIONS OF SINGLE-PHASE, 2-PHASE AND 3-PHASE SYSTEMS

	Single-Phase	Two-Phase	Three-Phase
Kilowatts	200	200	200
Generated voltage	2200	2200	2200
Percent line drop	5	5	5
Potential drop	110	110	110
Receiver Voltage	2111	2111	2111
Power-Factor, percent	80	80	80
Amp. per line	113.6	56.8	65.6
Resistance of each wire.	0.484	0.968	0.968
Section of conductor	209,310 cm	104,655 cm	104,655 cm
Nearest commercial size.	0000	0	0
Number of conductors	2	4	3
Resistance per group	0.965	0.968	
Weight of copper	12,708 lb.	12,708 lb.	9,531 lb.
Ratio of conductor	100	100	75

positive and then back to zero; then repeating the same performance, but in the opposite direction—that is, with a negative sign during the other half period, or 180 deg., which completes the cycle.

During the first 60 deg. of rotation of each half-cycle the total current of the system flows from phases *A* and *C* to the receiver and returns in the wire of phase *B* to the generator. During the next 60 deg. it flows from the generator in phase *A* only and returns again partly in phases *B* and *C;* and during the last 60 deg. of that half-cycle it flows partly in *A* and *B*, returning through wire *C* to the generator. The current of phase *A* then reverses its polarity and repeats the same performance, which also occurs in the same order in phases *B* and *C* following the time position shown in Fig. 6.

In practice the current is expressed in terms of the mean effective value which equals the maximum value of I divided by the square root of 2, and is the only value that need be considered.

Summarizing the results obtained in the 3 systems of distribution, as calculated before, gives Table I. From this table it is apparent that a 3-phase system, as to cost of conductor, carrying the same amount of power over the same distance with the same line drop, is 25 per cent cheaper than either single or 2-phase. Assuming an existing single-phase line of the size and capacity given above, if we change this line from single to 3-phase by the addition of a third wire of the same cross-section, the capacity of the 3-phase line for the same drop of voltage would be increased from 200 to 400 kw. or 100 per cent, with an increase in the weight of copper of only 50 per cent.

In the case of an existing 2-phase line having the conditions stated above, the removal of one of the 4 wires and the change from 2 phase to 3 phase, would bring the capacity of the 3-phase line, with the same drop of voltage, the same as that of the 2 phase line, saving one of the 4 wires, or 25 per cent of copper.

But the advantage of the 3-phase, 3-wire system is not limited to the economy in line conductors; it reaches further. The capital investment is also reduced, inasmuch as only 3 pins, 3 insulators and 3 ties are necessary at each supporting structure; 3 lightning arresters, 3 pole switches and fuses are required instead of 4-pole apparatus. These notable savings also extend to the customer service and installation, with corresponding reduction in the weight of conductors, number of insulators, pins, brackets, entrance tubes, etc., including smaller size of conduits and fittings. To the above should be added the savings in freight, haulage and labor of installation.

From the operating and maintenance point of view, the 3-phase, 3-wire system increases the efficiency and the safety, because decreased weight of the conductors reduces the mechanical stresses on the supporting structures, especially in cases of storms, sleet or high wind; the contingencies of mechanical and electrical failures of the insulators or insulation are reduced to ¾ the number of those occurring in a 2-phase system.

In favor of the single-phase system is the simplicity of the connections and wiring, as well as the permanence of the balance of the load. The 2-phase system has the advantage of requiring only 2 transformers for polyphase distribution, while the 3-phase system generally involves 3, although such a service can be equally well maintained with only 2 transformers connected either open delta or T. Where 3 transformers are used in 3-phase distribution, it is possible in case of accident to one unit to maintain the service with the other 2 at reduced capacity. In 2-phase distribution the loss of one transformer cripples the installation entirely, an incident of serious consideration—The Electric Journal.

IN PLANNING for America's Electrical Week, Dec. 2 to 9, various cities of the country are making great preparations for exhibitions and demonstrations.

In San Francisco, six shows will be held in various sections of the city, and a street car pageant with a number of floats will be run each night.

In Boston, the Edison Co. will have special meetings for the governing boards of the various municipalities in the vicinity, and will also entertain electrical contractors and workers in that territory.

In Syracuse, a large store will be fitted up to represent a home, a farm, a factory and a city, each section illustrating the use of electrical devices for that kind of work.

Flood lighting of the public buildings in Atlanta will be installed in connection with the Georgia State Electrical Show. At the Alabama Electric Fair, held in Birmingham, special effort will be made to show the advantages of electricity in the great rural sections of the south, and a bill of entertainment will be provided for out-of-town guests during the week.

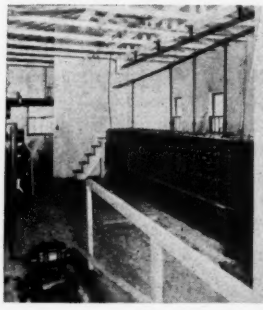
TO BE HONEST, to be kind, to earn a little and to spend a little less, to make upon the whole a family happier for his presence, to renounce when that shall be necessary and not be embittered, to keep a few friends, but these without capitulation; above all, on the same grim condition, to keep friends with himself; here is a task for all that a man has of fortitude and delicacy.—Robert Louis Stevenson.

Application of Electrolytic-Lime Process of Treating Sewage

IN communities where sewage must be treated before it is permitted to flow into neighboring streams or bodies of water, the electrolytic-lime process for sewage treatment is entitled to thoughtful consideration.

Recent tests conducted at a demonstration plant located at Decatur, Ill., have shown results which are extremely favorable. An indication of the size of this plant, which has a capacity of 1,000,000 gal. each 24 hr. is furnished by the accompanying views. Compactness of the units and low cost of installation are 2 of the commendable features of this installation.

Sewage is drawn off through a short lateral into a small temporary receiving well on to a horizontal screen, through which it passes to the intake of a centrifugal pump. The centrifugal pump elevates the sewage to a baffled box which acts as a grit chamber, and is so constructed as to still the flow and allow the settling of the mineral matter and heavy particles, and the measurement of sewage by weir. The pump lift to this chamber is 18 ft. The sewage passes through the rest of its treatment by gravity, first into the Landreth electrolytic machine where it receives the electrolytic and lime treatment, and thence to the settling basin.



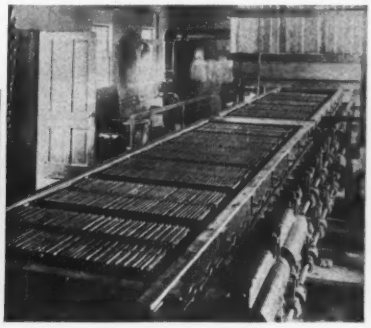


FIG. 1. ELECTROLYTIC-LIME PROCESS MACHINE FIG. 2. EXTERIOR VIEW DECATUR SEWAGE PURIFICATION PLANT
FIG. 3. COVER REMOVED FROM MACHINE SHOWING 22 BANKS OF PLATES

ELECTROLYTIC MACHINE

MOUNTED on a concrete base, the electrolytic machine is 23½ ft. long with an almost square cross section, 3 ft. on each side. It contains 22 banks of electrodes, which are shown in Fig. 3. Each bank consists of 48 iron plates 10 by 16 in., and 3/16 in. thick. In the space of ⅜ in. between plates are placed 2 revolving paddles to agitate and mix the sewage and keep the plate surfaces clear of sludge.

Every part of the sewage passes between the plates and is subjected to the electrolytic action, which is by current supplied at an average of 40 v. and 70 amp. The time of flow through the machine is one minute.

Lime is hoisted to the slaking tank situated on the second floor from which, after screening, it is discharged into a solution tank. It is then pumped to an elevated box and fed to the electrolytic machine.

SETTLING TANK

SEWAGE flows directly from the machine to a trough 17½ ft. wide, 3 ft. across and 2 ft. deep, from which it spills into the settling tank or may be by-passed into the sewer.

The tank is 61 ft. long by 17½ ft. wide, with vertical sides to 3 ft. below the surface, then sloping inward at an angle of 45 deg. to the central 10 ft. In this rectangular space, 61 by 10 ft., are 4 hoppers to receive the sludge as it settles, each terminating in a section of 24-in. tile pump acting as a sump.

Raised from the hoppers by a direct suction pump, the sludge is then pumped to the filter press where cakes are formed at a pressure of from 60 to 80 lb.

During the experiments at Decatur, it developed that with this process of treatment there is a strong possibility of eliminating the sedimentation basins, the treated sewage after leaving the machine passing direct to the filter press.

IN A PAPER before the Smoke Prevention Society, at St. Louis, on Carburization of Coal, A. G. Kinyon emphasized the need when handling powdered coal of intimate mingling of air with the coal particles, and maintaining the contact between as many particles of coal dust and air as possible up to the point where combustion commences. Since a cubic inch of coal, when reduced to a powder, 85 per cent of which will pass a 200-to-the-inch mesh screen, becomes 35,500,000 particles, with which 72,000,000 particles of oxygen must combine to secure perfect combustion, the need for full and continuous intermingling becomes apparent.

If slag forming particles are contained, they fuse and combine with other particles until the weight is sufficient to precipitate them to the bottom of the furnace, and this may occur at the time when gases come in contact with the heat conducting surfaces, thus coating them with slag. If the intermingling of air is so complete as to make combustion instantaneous, the slag particles are practically all formed at one point and may be precipitated before the gases reach the heating surfaces.

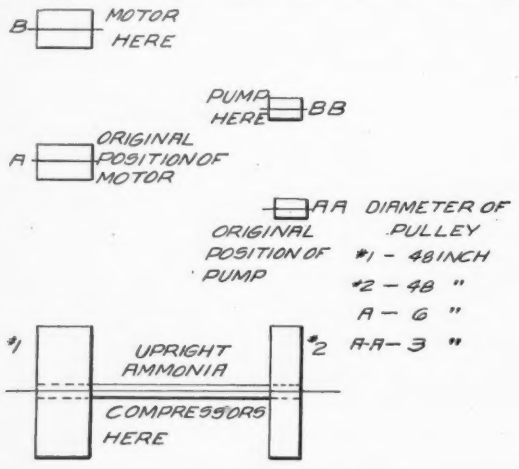
THERE CAN BE no bigger, broader religion than helping the other fellow. We can all profit by watching him, to see how he makes successes, where he makes mistakes; congratulate on the one, suggest on the other and apply both ideas to our own work. But we can's *copy* and get away with it long, for our methods must fit us—not be patched on.

Refrigerating Plant Operating Difficulties

TROUBLE WITH CONDENSER PRESSURE TRACED TO SLIPPING BELTS. BY A. G. SOLOMON

IN a small refrigerating plant which had been in operation but little over a year and which had received no care, all kinds of trouble were encountered. No engineer was in charge and the man who did the operating knew just enough to start up and shut down again when the 2 small storage rooms were cold enough. He also knew how to hold a certain back pressure and how to keep the compressor from freezing up too much.

This was a 10-ton motor-driven machine and when first installed, somebody must have tried to save belting; for the centers were so close that the belt would continually slip unless kept so tight as nearly to burn up the motor bearings. When the motor had been pushed



RELATIVE LOCATION OF PULLEYS

back as far as the slotted base would allow, it was decided to move the motor 5 ft. farther from the compressor and put a piece in the belt. This helped matters greatly; but, as the belt was badly oil soaked, the slipping was not entirely stopped.

About this time it was noticed that the condenser pressure was higher than usual and often went far beyond the comfortable point.

The permanent gas was purged from the condenser, but did very little good. Almost everything was tried, but the solution of the problem still remained a mystery. The peculiar thing was that sometimes, for an hour or two, the pressure would remain at 200 or 210 lb., and then gradually increase to 250 or 260 and still keep going up till the machine was stopped. There were days when this compressor was stopped 4 or 5 times during a hot day when it was badly needed.

To make the cause and the remedy more easily understood, the sketch will help some. No. 1 shows driven pulley on ice machine; No. 2 is flywheel which also has a belt on it and serves as the driving pulley for the centrifugal pump for the condensing water; A is position of motor before moving, and B position after moving; AA was original position of condenser pump, and BB final position.

With the belt tight and not slipping, the ammonia compressor made 120 r.p.m.; but when slippage occurred, this speed would fall as low as 100, and sometimes lower, and the attendant would not notice it. With the slowing of the compressor and the resultant slowing of the condenser pump, the condenser pressure would begin to rise. The high condenser pressure caused an increased back pressure and the added load would make the belt slip still more, till finally the machine had to be stopped or it would stop itself. When the compressor stopped with a load, the belt would slip on the motor pulley and, of course, the belt could not last long, as it was being badly burned every time this happened.

When the trouble was finally traced to its source, the centrifugal pump was moved back as the motor had been and new belts were put in place of the old oil-soaked and burned ones.

Also, a little change was made in the pipe work so that water could be flowed through the condenser, even though the pump should be put out of service entirely. A city water line fed into the cooling tower pan to take care of the waste caused by wind and evaporation. The outlet water line from the condenser was piped to the sewer as well as to the suction of the pump. The valve in this sewer line was sometimes left open a turn or two and the city water also turned on enough to supply the waste. By using this arrangement, together with the pump, no more trouble was experienced.

A final word in regard to the slippage of belts. By a little thought and a few figures, it will readily be seen that with the different sized pulleys used in an installation of this kind, very little slippage at the motor and a little more at the pump will cause enough loss to affect the water supply seriously. And centrifugal pumps do not do much good if their rated speed is decreased.

AT ORDINARY temperatures, air will hold about 5 to 28 per cent of gasoline vapor. As gasoline vapor is about 3 times as heavy as air, in a room containing a mixture of the vapor with air, the vapor is found in largest proportion near the floor.

The limits of explosibility of mixtures of gasoline vapor and air are between about 1.4 and 6 per cent of gasoline vapor, although dangerous flashes may be produced with mixtures containing less and more than these proportions. In other words, there is needed only a small proportion of gasoline vapor to render air explosive—1.4 cu. ft. of vapor to 97.5 cu. ft. of air. One gallon of gasoline can under ideal conditions render 2100 cu. ft. of air explosive.

A dangerous feature of gasoline vapor is that it may travel a considerable distance from the gasoline and there be ignited, the flash traveling back to the container of the liquid and causing a roaring fire in a few seconds. —Bureau of Mines.

AT THE Letten hydraulic power station of the Zurich (Switzerland) Electrical Power Co., surplus power which was being wasted during the winter months has been utilized to make steam for station uses. The boiler with 1800 sq. ft. of heating surface and using 85 kw. supplies 3800 lb. of steam in 24 hr., which is not very good efficiency, but, since the electrical energy costs nothing, is good economy.

Reclaiming Contaminated Ammonia

METHOD OF REMOVING FROM SYSTEM; EASILY RECLAIMED

ABOUT 3:30 a. m. I was awakened by a telephone call from the night engineer of our ice plant and received the following message: "Something is wrong in the tank; there is a hissing noise, but I can't see anything wrong." Asked how long this had been going on, he replied: "About 15 min." I advised the engineer to shut down immediately and I would go over.

Upon arriving at the plant I found the tank man, who had been on duty about 12 hr., trying to do the work of 2 men, harvesting ice and filling cans at one and the same time. Due to lack of care, a can of water had become lodged on an upper coil. Instead of lowering the can properly with the use of the crane, he attempted to dislodge it with the use of a hook used in removing covers, which resulted in dislodging the can, but with such force that the bottom pipe of the coil was rent, allowing the entire charge of ammonia to escape into the brine. The engineer at the time was unaware of the accident and consequently did not stop his machine.

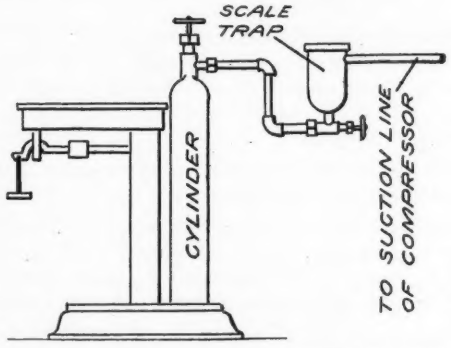


FIG. 1. PLATFORM SCALE, AMMONIA DRUM AND SCALE TRAP

To make a long story short, I instructed the tank man to pull all of the cans in order to lower the brine, hoping the affected coil would not be found at the bottom. Then with the steam pump I withdrew the brine, storing it in cans temporarily. After locating the break, I plugged one end of the coil and used a flange, equipped with a valve, on the other end. We then started the machine, "Big Liz" turning over very slowly, at about 20 r. p. m. After pumping 300 lb. pressure on expansion coils, I opened the temporary valve and blew out the coil. The pressure was maintained for 2 days, or until all trace of moisture had been removed, when a new section was installed and tested by pressure. After allowing the pressure to stand overnight, I pumped a vacuum.

After a short time we were ready to recharge the system. The ammonia was taken in gradually, the machine turning over slowly. After 300 lb. of ammonia had been charged, we heard the old familiar "knock" in the compressors, while the saturated ammonia was escaping at the pistons, indicating the existence of pockets in the expansion coils and that the system still contained brine.

As will be noted in Fig. 1, the suction line was equipped with a scale or sediment trap, with a purge valve at the bottom. From this valve I extended a ½-in. line to an empty ammonia drum placed on a platform scale. The purge valve was then slightly opened and then gradually opened wider, while in the meantime the machine was running slowly. By this means the gas passed over or through the trap to the machine, while the wet or contaminated ammonia would fall to the bottom of the trap, then through the purge valve into the drum referred to. When about ⅔ full, I placed another drum on the scales, and then, testing the ammonia (atmospheric test), found that it was about half and half.

The management declined to return the contaminated ammonia to the factory, believing it worthless. Holding an opposite view and desiring to demonstrate my theory, I made the following experiment.

An ice can, about half full of water, was brought into the engine room, in which I placed the drum of contaminated ammonia. Then uncoupling the indicator pipes from the cylinder valves, I ran a ½-in. line to the tank of water containing the drum, connecting the line to one of the indicator valves. I then made a connection with the suction side of the compressor through the bypass from the drum of ammonia, as shown in Fig. 2.

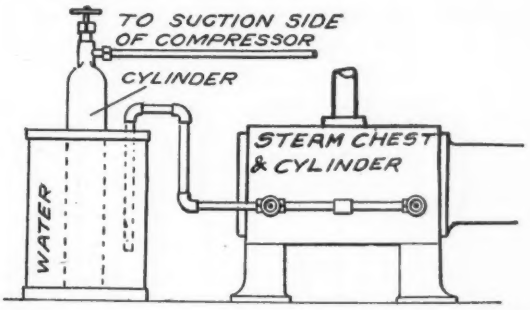


FIG. 2. METHOD USED TO RECLAIM CONTAMINATED AMMONIA

Next I opened the indicator valve, heating the water in the can; opened the bypass valve slightly, as well as the valve on the drum. In this way I reclaimed or regenerated the contaminated ammonia. Upon testing, we found that only a perfectly dead, strong-smelling water remained.

The foregoing plan was followed about 2 weeks and worked to perfection, everything being in apple-pie order with no traces of water in the system at the end of the season.

The machine used was a twin-cylinder vertical type, but I am confident that the same scheme can be used on a horizontal machine.

J. A. W.
—Ice.

AS A RESULT of war conditions in England, women are being employed to a considerable extent in power houses as switchboard attendants, for operating engines and stokers and similar work. Operation of cranes seems, however, a duty which they do not readily manage. The Power User expresses the opinion that while women do and will succeed admirably in minor duties, they are not likely to be satisfactory in positions of responsible charge of plants.

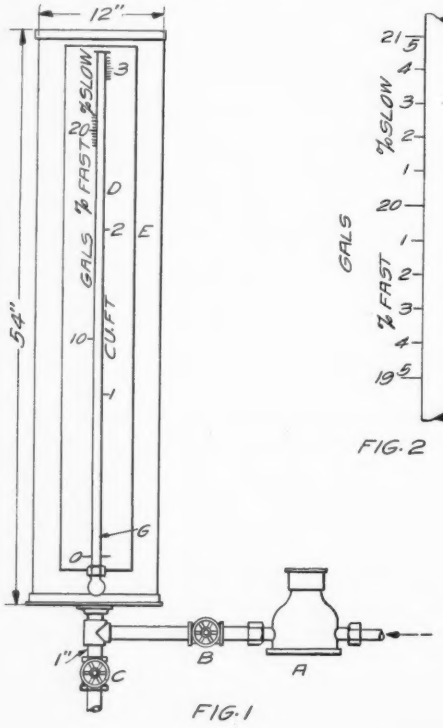
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Water Meter Tester

THE ACCOMPANYING drawings illustrate a tester or prover for water meters as made by the writer, and found very convenient for testing service meters.

The tank E, Fig. 1, is made of No. 20 galvanized iron of the dimensions shown, and will contain 3 cu. ft. of water. G is a ½ by 48-in. gage glass. Back of the glass is a board, D, upon which is laid off on one side of the glass gallons, and on the other side cubic feet, as shown, as water meters are calibrated in both gallons and cubic feet. Figure 2 shows how the scale is calibrated at the 20 gal. mark, to show by direct reading



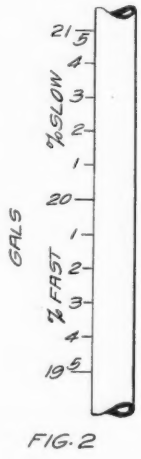


FIG. 1. ARRANGEMENT OF TANK AND METER
FIG. 2. METHOD OF LAYING OFF SCALE

the percentage fast or slow of the service meter. Divide from the 19 to 20 gal. mark into 5 equal parts, marking this per cent fast. Divide from 20 to 21 into 5 equal parts, marking this per cent slow, as shown. To calibrate the cubic foot scale for percentage fast or slow, divide the distance of one cubic foot on the scale by 100; this will equal 0.01 cu. ft. Below the 3 cu. ft. mark set off 0.03, 0.06, 0.09, 0.12 and 0.14, marking these 1, 2, 3, 4 and 5 per cent fast, respectively. Above the 3 cu. ft. mark set off 0.03, 0.06, 0.09, 0.12 and 0.16; mark these 1, 2, 3, 4 and 5 per cent slow, respectively.

To use the tester, connect the service meter to be tested at A. Close valve C, open B, and allow water to flow through meter until the first index hand registers 0, and shut B. If the meter registers in gallons, and is from ⅝ to 1-in. size, one revolution of the first index hand will equal 10 gal. Open drain C until the water in the tank drops to 0 on the scale. Close C, open B, allow water to flow until the service meter registers 20 gal. Note the water in the gage glass; if it should show 2 under 20, the service meter is 2 per cent fast; if over 20, it is slow.

As an example: The service meter registers 20 gal., the tester 2 below 20. The amount of water in the tester is 19.6 gal., as each division = 0.2 gal., 20 ÷ 19.6 = 1.0204, or 2.04 per cent, 2 per cent being near enough for practical purposes.

If the service meter is calibrated in cubic feet, the cubic foot scale is used instead.

The gallons can be laid off on the scale by measuring the water; the cubic feet, by allowing 7.5 gal. per cu. ft. Or the contents can be estimated in cubic inches, and divided by 231 for gallons, and by 1728 for cubic feet.

R. L. MOSSMAN.

Boiler Room Log

ACCOMPANYING is a diagram of a boiler room log which I believe is worthy of attention. It will be seen at a glance that the sheet contains a great deal more data than is usually put down on a plant record sheet, but this is done more for the sake of having such data on file and complete at some later date when it is sure to be of service. For instance, if, in connection with some changes or the installation of new equipment, it is desired to know the cost of cleaning and repairing the boilers for any given time, a compilation of the time, labor and material costs, as taken from the various daily logs, would be of immense service. In other words, the log is designed to show not only the amount of coal burned, the water evaporated, etc., but much other data and information which is necessary in making calculations at a later date. The log gives practically all the data that is necessary to figure out a daily test on the plant. In many plants the recording or indicating equipment may not be available to secure all the data that is called for; in that case, it shows the need for installing it.

The logs are numbered consecutively, and each dated.

The first record is a graphic curve or line showing how long each boiler unit is in service that day, if fired,

the line is drawn -----, if banked :-:-:-:-:. The total hours each boiler is in service is noted at the right-hand column. The name of the fireman in charge, and the period of time covered is shown at the bottom of the boiler record.

Data as to the boiler load, etc., is then figured and placed in the spaces provided.

In the case of temperature reading, etc., provision is made for taking a certain number of readings which are averaged and carried in the column at the right. Space should also be provided under "Boiler Blown Down," "Soot Blower Used," etc., to care for the maximum number of times these are done. In the columns

BOILER ROOM LOG

Date _____ Log. No. _____

Boilers in Service. Fired ----------
Banked -:-:-:-:-:-:
Noon

Unit No. 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 Total Hours in Service.

B1
B2
B3
B4
B5
B6
B7
B8

Fireman in Charge ←——name——→←——name——→←——name——→

Normal rated B.H.P. in service. Maximum _____ Time _____ Duration _____
Minimum _____ Time _____ Duration _____
Average B.H.P. developed on 34-1/2 lb. per hour basis _____
Boiler load factor _____

	Average		Average
Temperature outside		Grade of coal burned	
Boiler Room temp.		Average Heat Value per Lb.	
Steam Pressure		Amount of coal burned	
Temperature of feed		Amount of ash	
Condenser returns		Amount of water fed	
Heating returns		less blow-off	
Raw Make-Up Water		Net evaporation	
Temp. Flue Gases			
Draft - ins. water			
Per cent CO_2		Quality of steam	
Per cent CO			
		Lbs. water evap. per lb. coal	
	when gauges quantity	Evaporation from and at 212°	
Boilers blown down		Heat efficiency of boilers	
		Lbs. coal per lb. steam	
	when time	Lbs. water per lb. steam	
Soot Blower used			

Total Costs for Day.
Coal (lb.) _____
Water (gal.) _____
Water treatment _____
Firing Labor _____
Cleaning Boilers _____
Repairing Boilers _____
Oil & Waste _____
Supplies _____
Special _____
Total _____
Cost of generating one pound of steam exclusive of interest, depreciation, salaries or general maintenance _____

Cleaning Boilers — Unit No. ____ time ____

Repairing Boilers — Unit No. ____ time ____ material ____

Chemicals used for treating water
_____ at _____ _____
_____ at _____ _____

Statement of Supplies used:

Mention any special remarks concerning operation of plant, etc.

CONVENIENT AND COMPACT BOILER ROOM LOG SHEET

Feed Pump Troubles

WHERE feed water regulators are used on the boilers it is necessary to have a pump governor on the pump to hold the pressure in the feed line down to a reasonable limit when the regulators close. The feed water pressure as a rule should be carried about 10 to 20 lb. above the boiler pressure, and the governor set to limit the excess pressure to this amount to eliminate unnecessary strains on the feed pumps and line. Some excess pressure is necessary to overcome friction, and lift the valves in the feed line.

At one time the gaskets under the water cylinder heads and discharge valve bonnet of our feed pumps

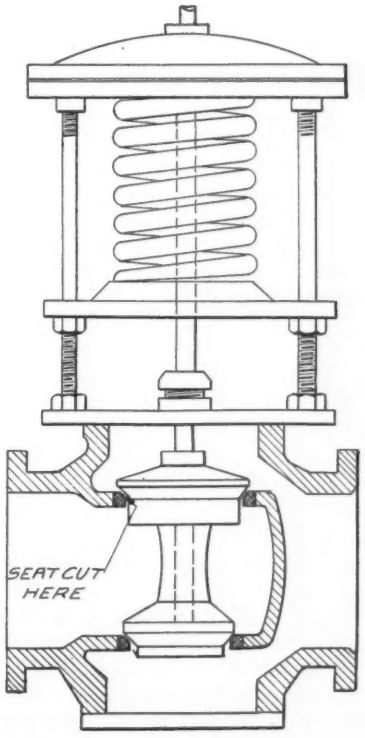


FIG. 1. SECTION OF PUMP GOVERNOR

at the right the evaporation is obtained after providing for blowoff loss, etc., all of which, taken in conjunction with the coal data, leads up to the heat efficiency of the boilers and the evaporation factors.

The total costs for the day are then summarized under the various headings, from which can be obtained the general cost of generating per pound of steam. The blank space at the bottom and the reverse side of the sheet should be used in describing any special happenings in the plant, etc., or any information that is desired to supplement the data given above.

The charts are also punched so that they may be filed in a loose-leaf holder. M. A. SALLER.

gave considerable trouble and the packing on the pistons gave out in a very short time. Applying a gage to the discharge chamber we found the trouble to be due to excess pressure in the feed line. The boiler pressure was 100 lb., and the discharge line pressure ran up to over 200 lb. The feed line was examined for stoppages or scale but was found to be clear, and there was no sign of packing blocked under the check valves or scale in the internal feed pipe, a thing that is frequently the cause of high feed line pressure. The pump governor was adjusted to reduce the pressure but without any results, and did not lower the pressure in the feed line. The governor, shown in Fig. 1, was then taken apart for

examination, and it was found that the seats were badly cut from wiredrawing steam through them, the lower seat being much worse than the upper seat. The discs were hurriedly ground in with emery in the limited time available and the valve reassembled, but with little if any better results. At the next opportunity, the valve was taken apart again and a reseating machine used to cut the seats down until all the scores were out. In doing this, we had to be careful not to ream the seat out too large, as the valve might slip through. It is also particular that as much be taken off the top seat as the bottom one, although it may not be so badly scored, as the discs are solid on the stem. The valve was then placed in a lathe and a cut taken off each disc, and in order to get both discs to seat it was necessary to take a cut off, then try the disc in the seats, and several trials were necessary to get both discs to seat when marked with red lead. The discs were then ground in

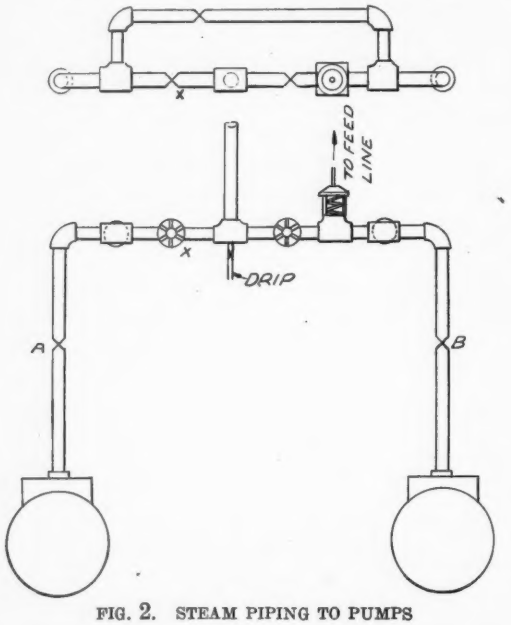


FIG. 2. STEAM PIPING TO PUMPS

with a mixture of grease and powdered glass. I find that powdered glass is superior to emery for grinding brass, as it does not score the seat so badly and makes a smoother finish. It takes a little longer, but does better work. I use grease for the reason that it stays on the seat better and does not run down into inaccessible places where it cannot be removed as does oil and emery. Both seats were ground in at the same time, and chalked occasionally to make sure that a good seat was secured before stopping. The valve was turned by means of a large screwdriver. After properly fitting the valve and adjusting for the proper excess pressure, it closed off tight whenever the feed line pressure reached a predetermined pressure.

There are 2 feed pumps installed, duplicates, both controlled by the same governor. The piping layout is shown in Fig. 2.

Another time after the pumps had been shut down for general repairs, we had considerable trouble from blowing gaskets in the water end. The trouble was not located for some time and was laid to poor gaskets. After 3 or 4 had been blown out including a wire inserted Ebonite, the engineers began to investigate for the trouble elsewhere. No gage was attached to the discharge line, but the trouble was thought to be due to obstructed feed line or springing heads. New heads were ordered made heavier, but did not help matters any.

One day, after about 2 weeks of this trouble, one of the assistant engineers happened to put his hand on the valve marked X in Fig. 2, and was surprised to find that it was about halfway open, which bypassed the governor and allowed the steam to enter the cylinder after the governor had closed from excess pressure. This condition had probably existed from the start, and had been overlooked, as the valve is seldom used. This bypassed steam kept the pump moving after the regulator closed until the pressure in the water cylinder balanced that in the steam cylinder or about 260 lb. water pressure. This showed why the gaskets would not hold. Closing the valve of course stopped the trouble and since that time a pressure gage has been permanently attached to the discharge chamber of each pump.

Another time, some discussion arose as to just how much steam pressure was required in the cylinder to operate the pump at the desired speed. The pump depends entirely on the governor, and the throttles "A and B" are kept open when running. A pressure gage was attached to the steam chest and showed from 50 to 55 lb. when the pump was running at medium speed with the regulators open, and 60 to 65 lb. when they were closed with the pump barely moving. One pump required about 5 lb. less than the other, the figures given being the maximum. This shows that the governor had to act as a reducing valve at all times, and reduced the pressure about 45 per cent.

The spiders of the water pistons were not a very close fit in the cylinders, the lining of which became somewhat worn and the hydraulic packing used, which was purchased in coils, did not hold as long as it should even after the pressure trouble was eliminated, and frequently it became necessary to remove the cap of some of the check valves to remove pieces of packing which had lodged there. As a remedy for this, we purchased the same kind of packing made in solid rings to fit the pistons, and find that although it costs a little more per pound, it lasts a great deal longer than the same kind put in in split rings, as there is no chance for the water to start through the joints and eventually break the packing out. The pistons are now packed once a year when the annual overhauling is done. J. C. HAWKINS

Banding a Large Armature

THE INTERESTING article entitled, Some Electrical Repair Kinks, page 879, Oct. 15 issue, brings to mind an experience I once had banding the 6-ft. armature of a generator direct connected to a 24 and 48 by 48-in. Allis-Chalmers cross-compound Corliss engine, rated at 1500 hp.; the rigging used was like that illustrated and described in the article referred to.

The difficulty experienced, was in being unable to stop the engine quickly enough in case the banding wire kinked, which sometimes happens. The slowest possible speed at which the engine would just pass the dead centers, was still too fast, with respect to stopping the engine in case of the wire kinking; that is, after the

steam was entirely shut off, there still remained enough steam in the engine cylinders and in the receiver to admit of at least 2 or 3 revolutions being made. Owing to local conditions as to distances, it was necessary to be able to bring the engine to a dead stop within one revolution after the steam was shut off. This was done by a man at the engine upon signal from the man tending the wire and the clamps. Several attempts had been made in the past to band the armature by running the engine slowly as just described; but all were failures, for the kink would catch in the clamps, the wire would break, and that portion of the band already on the armature would slacken, and so time and wire were both lost so far as that particular job was concerned.

Because of the troubles referred to, we used to run the engine by hand when the armature required banding; that is, one engineer would take the high-pressure side, and another would take the low-pressure side, and with the starting bars in the respective wristplates, work the valve gear and slowly turn the engine over at will. If a kink appeared, the watcher would announce it to the men at the engine, who could quickly close the throttle, and by the handling of the starting bars bring the engine to a dead stop before the kink could do any harm.

One of the engineers on the job, whose arms had become quite sore from the oft repeated working of the starting bar, conceived the idea of shortening the cutoff cams on the high-pressure cylinder, so that with the engine running as slowly as possible without stopping when the cranks were passing their centers, the steam valves just picked up and almost immediately dropped again. The result was, that with the throttle valve just about cracked and the steam valves cutting off immediately after admission, there was just enough steam admitted to turn the engine slowly to overcome the friction of its parts, and when any sign of a kink appeared, the throttle was quickly closed, and the engine brought to a dead stop within ¾ of a revolution. This enabled us to catch the kink and get it straightened out without any mishaps. CHAS. J. MASON.

Care of Leather Belts

MR. ESTLICK'S article in Nov. 1 issue concerning N. G. Near's experiment sounds about right.

Running the flesh side next to the pulley is the natural way the belt tends to bend, thus giving greatest contact between it and the pulley. Especially is this true in case of small pulleys. No doubt, while new, there will be some air pockets under the belt; but just look at a new belt that has run for a short while with the hair side to the pulley and note how "spotted" it is. These spots show where the belt failed to touch the pulley and therefore there must be some air pockets. No matter which side is run next the pulley there will probably be air pockets while the belt is new; but the flesh side will yield more readily than the hair side, and it is the writer's opinion that belts run this way will give as good if not better service than when running with the smooth side to the pulley. JOS. STEWART.

WILLIAM THOS. ESTLICK furnishes some good arguments in his friendly "rebuttal" to my experiment. I have no doubt but that the flesh side of a belt can be made as smooth as the hair side, in which case its pulling power should be as great as the pulling power of the hair side; but there are some strong arguments on the other side also—so strong that all manufacturers of leather belting of my acquaintance always put the hair side outside on double, triple, or 4-ply belts. On single thickness belts, they stamp these words on the hair side: "Run this side in contact with the pulley."

The pith of the strongest argument is this: The flesh side is the stronger side of the two and it should be protected. It is protected in double belts by placing it inside. It is protected in single belts by running the flesh side outside.

The hair side being the smoother, and therefore the "grippier," and the flesh side being the stronger, it is logical that the hair side should run next to the pulleys.

A test can be easily made to prove that the hair side is the weaker by splitting a narrow belt exactly through the middle, separating the flesh and hair sides and then pulling apart with known weights.

It might be possible to run a belt without wearing it out by placing so much dressing on the pulley side that the leather never comes in contact with the pulley surface, but I "ha'e me doots" about the probability in actual practice. There is always a certain amount of creep between any pulling belt and the pulley, and it would be pretty hard to prevent some wear without putting a wear-resisting substance between the rubbing surfaces. I know that that method is actually followed in the manufacture of some belts, for instance in combining leather with cotton. The cotton is very strong and is placed inside. The leather is also strong, but a better wear-resister, and so is placed outside.

The other day I saw a sample belt which was a combination of steel and rubber. Naturally, the rubber was placed outside and the steel inside. Actual use will decide whether or not that belt will some day oust all other makes from the belting field.

Lastly, it is claimed that actual tests have been made on belts run side by side, some of them with flesh side next to the pulleys and some of them the other way. Conditions otherwise were as nearly identical as could be made. In every test, the belts with hair side next to the pulleys won the decision.

True, this does not prove that Mr. Estlick is wrong. I doubt if the belts in the above-mentioned tests were treated as carefully as Mr. Estlick would have treated them. But I believe he will agree with me that manufacturers have pretty good reasons for making belts the way they do. It is human to err; it is therefore human to misuse belts unless you have studied belting carefully. And since users of belting in general don't know much about belts, the manufacturers do the best they can to give the buyers and users a square deal.

N. G. NEAR.

Annual Inventory Time

THIS IS the time of the year when most concerns "take stock" and make an inventory of their business so that they can determine what has been accomplished during the past year and so that they may have a basis on which to plan for the coming year.

This opportunity for an annual resume should prove of especial value and interest to the power plant. In

addition to the opportunity to list and catalog the equipment installed and improvements made, and determine present valuations, there is the chance to strike off totals of the amount of materials and supplies used, the amount of power produced and the average cost of operation covering the period of a year, i. e., a summing up of the work accomplished, costs and records for the year.

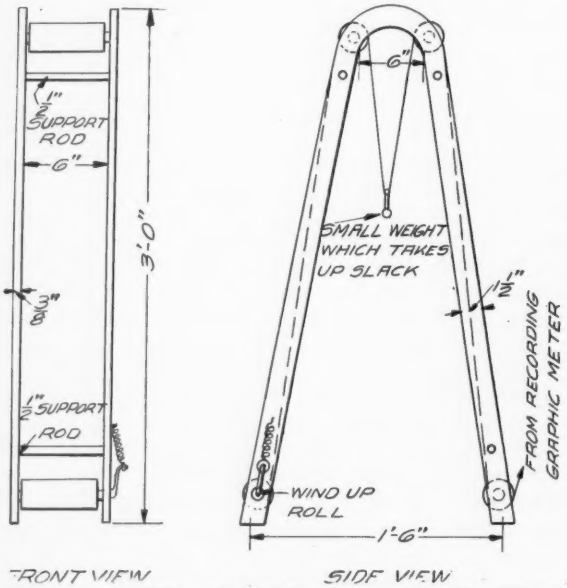
Then taking into account the fact that the owners are usually inclined to make appropriations for improvements and changes after they have closed the year's business and know where they stand, the time is also here for making a general examination and test to determine the efficiency of the various equipment and what it is capable of doing, all of which information offers a most excellent basis on which to report recommendations as to changes that should be made immediately or in the course of the new year.

The writer has always found it of great advantage to stand off, once a year, at inventory time, to take an impartial look at his plant, to bring together data as to what has been accomplished and what has not been done that should have been taken care of; to study wherein things could have been improved during the past year and to plan for the betterment of operating conditions in the future. In other words, this should be "house cleaning" time for the power plant operator.

M. A. SALLER.

Graphic Meter Take-Up Stand

THE ACCOMPANYING sketch is a take-up stand for holding and winding up the daily record sheet of the recording graphic meter.



METHOD OF TAKING UP LOOSE END OF GRAPHIC METER RECORD

About 4 ft. of paper is unwound each day and this amount is taken up by the small weight which keeps the paper tight. It was designed by J. Beame of the Nevada Valley's Power Co. ARTHUR C. DAMAN.

Boiler Inspection

I HAVE READ several comments in Practical Engineer in regard to boiler inspectors and some of their methods, and would like to add my voice to the chorus against the abuse of what is intended to be a safeguard against loss of life and property.

Our plant is inspected regularly by a representative of one of the oldest and largest insurance companies in the country. One day he came to examine 2 of our boilers, and as the third boiler was also dead he examined that. Now, the reason for this boiler being dead was that the blowoff pipe had cracked right below the boiler for a distance of about 15 in.; this, however, was not mentioned to the inspector at that time.

While examining this boiler, he took his hammer and crawled into the combustion chamber, where he proceeded to tap around on this blowoff pipe. He not only pronounced that pipe in good condition, but made a written report to that effect and signed his name to it.

The next time he came, we had just put a new set of tubes in one of the boilers, but had not yet beaded up the ends; but in his report he wrote: "All seams and *tube ends taut.*"

In all of his reports he notes that the steam gages are accurate, while, in fact, all 6 gages register different pressures, the difference running from 5 to 25 lb.

There are pipes in our plant right now carrying 125 lb. pressure, that I know could easily be punctured with a knife blade; in fact, one pipe was pierced with a hardwood tooth pick about 2 months ago, the boiler at that time, of course, being dead.

Yet the man that inspects these boilers would be the first one to tack up a sign reading "Safety First."

This is not intended for a knock nor a criticism, but a plain statement of facts. R. M. PACKINGHAM.

W. H. INGERSOLL, Sales Manager for the Ingersoll Watch Co., an authority on price maintenance, said in a talk before the Pilgrim Publicity Ass'n of Boston: "A manufacturer of an advertised and trade-marked article should have the right of establishing and protecting the consumer price. Because, having established through publicity a demand for his article, he has created a condition of market that automatically goes with the article to the retailer but which the retailer does not purchase. Because, having prepared at his own expense the foundation upon which depends the successful resale of his article, he should have the right to protect the established reputation for quality through the maintenance of a uniform price. Because the trade-mark placed on the article is the sole property of the manufacturer, and no rights in it or to it are transferred to the retailer by the act of his purchase of articles bearing it for the purpose of resale, and consequently the retailer should not be permitted to sell the article for any price other than that at which the article was manufactured to be sold."

WHEN A MAGNET is brought near a carbon incandescent lamp it will affect the filament. For a direct-current circuit, the deflection will be steady. On an alternating-current circuit, the filament will vibrate rapidly.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Corliss vs. Poppet Valve

IF THE valves on a Corliss engine remained tight or did not leak steam and did work properly, would not a Corliss engine be about as economical as a poppet valve engine? If not, then why is a poppet valve engine so much more economical than other engines?

D. L. D.

Storage Battery Construction and Operation

PLEASE DESCRIBE some form of lead storage battery.

2. Would it be proper to assume that such a battery stores electricity as a tank stores water?

3. When is a battery said to be discharged?

ENGINEER.

ANSWERS

1 and 2. CELLS which are reversible to a high degree, that is, those in which the chemical conditions after discharge are brought back to the original condition simply by causing current to flow in the opposite direction, or "charge," may be used as storage batteries. Storage batteries are sometimes called electric accumulators, and have an hydraulic analogy in a tank which may be filled and emptied of water at will, although the amount of electric energy obtainable from a battery is always less than that put in.

The original, or Plante, storage battery consisted of 2 plates of metallic lead immersed in a vessel containing sulphuric acid. An electric current being sent through the cell, the surface of the positive plate was converted into peroxide of lead, PbO_2. This was called charging the cell.

After being thus charged, the cell could be used as a source of electric current, or discharged. Plante and other authorities consider that in charging, PbO_2 is formed on the positive plate and spongy metallic lead on the negative, both being converted into lead oxide, PbO, by the discharge, but others hold that sulphate of lead is made on both plates by discharging, and that during the charging PbO_2 is formed on the positive plate and metallic Pb on the other, sulphuric acid being set free.

The acid being continually abstracted from the electrolyte as the discharge proceeds, the density of the solution becomes less. In the charging operation this action is reversed, the acid being reinstated in the liquid and therefore causing an increase in its density.

The difference of potential developed by lead and lead peroxide immersed in dilute sulphuric acid is about 2 v. A lead-peroxide plate gradually loses its electrical energy by local action, the rate of such loss varying according to the circumstances of its preparation and the condition of the cell.

In the Faure or pasted cells lead plates are coated with litharge made into a paste with acidulated water. When dry these plates are placed in a bath of dilute sulphuric acid and subjected to the action of the current by which the oxide on the positive plate is converted into peroxide and that on the negative plate reduced to finely divided or porous lead.

The "Chloride Accumulator" made by The Electric Storage Battery Co., consists of modified Plante positives and modified Faure negatives. The positive plate, called the Manchester type, consists of a hard lead grid into which are pressed "buttons" of corrugated pure lead tape, rolled into spirals. When electrolytically "formed," these buttons become coated with lead peroxide. The negative is the so-called "Box" type, in which the grid is made in 2 halves which are riveted together after "pasting" with lead oxide, the latter upon charging being reduced to spongy lead. The outside faces are covered with perforated lead sheet, which serves to retain the spongy lead or active material.

3. Discharges should be stopped when the cell voltage has fallen to 1.80 v. with current flowing at or about the normal rate. The fall in specific gravity of the electrolyte is also useful as a guide on the discharge and the manufacturer should be consulted as to the proper limit.

O. H. H.

Armature Winding Problems

HOW WOULD you find the spread of armature coils and that of commutator leads? Is there a special rule for this?

If a 500-v. wave-wound armature has 53 coils of 4 wires each and 212 commutator segments, how may I determine the spread of the commutator leads?

Why is one set of commutator leads carried farther to one side of the center line of the coil than the set carried to the other side of the center line of the coil?

F. H.

A. The spread of an armature coil is usually made as nearly as possible equal to the distance on the armature from center line to center line of 2 adjacent poles. This spread is generally designated as "full pitch," and in terms of the number of slots spanned by the coil, it is equal to the total number of slots on the armature divided by the number of poles. Thus for a 4-pole machine with 60 slots "full pitch" would be 15 slots or with one side of a coil in slot number 1 the other side would fall in slot number 16.

For lap or multiple windings, the coil span is sometimes made slightly less than full pitch; a saving in the end winding copper is thus made at the expense of a slight decrease in the generated voltage for a given

field strength. For wave or 2-circuit windings the coil span is made as nearly as possible full pitch.

In a lap winding, the coil ends connect to adjacent commutator bars. In a wave winding, the pitch of the coil ends in terms of commutator bars is:

$$\frac{2(N+1)}{P} \text{ for progressive winding.}$$

$$\frac{2(N-1)}{P} \text{ for retrogressive winding.}$$

Where: N = total commutator bars, and P = number of poles.

For example, with a 4-pole machine, wave wound, 117 bars for a progressive winding the pitch on the commutator would be $\frac{2(117+1)}{4}$ or, 59 bars and the coil ends would be connected to bars 1 and 60. For the winding given having 53 coils, 4 wires per coil, 212 bars, wave wound, assuming that this is a 6-pole machine with no dead bars or coils, the expression for a progressive winding applies and the spread of the coil ends is 71 bars, or the coil ends are connected to bars 1 and 72. If this is a 4-pole machine it must have one dead bar and one dead coil, it will then have 211 active bars and may be either a progressive or a retrogressive winding. If progressive, the coil ends will be connected to bars 1 and 107, pitch being 106 bars; if retrogressive, the pitch is 105 and the coil ends will be connected to bars 1 and 106.

By connecting one coil end a greater number of bars from the center line of the coil than the other end, the neutral or brush position is shifted around the commutator. Such a shifting is employed for mechanical reasons only. The brush arms may be mounted where it is most convenient mechanically, and the brush position made to conform to this mounting by properly connecting the coil leads to the commutator.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.
M. C. TURPIN.

Proper Method of Turning up Piston Rings

WILL YOU kindly give me directions for turning up piston rings?

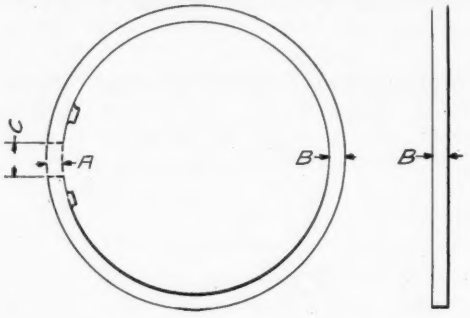
In the plant where I am employed, the machinist makes the ring to size on the inside and over size on the outside. He then makes a slot about 5/16 to ½ in. in width, squeezes the ring together and turns it to size on the outside. This I claim is wrong, as I think the ring should be turned to size on the inside, and outside the slot should be made just wide enough to allow the ring to enter the cylinder, without further turning. G. M. G.

A. The practice which your machinist follows of giving the rings a final turning after the gap is cut out is considered best. The reasons why will undoubtedly be apparent from the following description which is abstracted from Halsey's Handbook for Machine Designers and Draftsmen:

The ring casting is not made round, for if the pattern is turned up round, it will be found when the gap is cut out and closed up, that the casting will have so departed from its circular shape, that, unless excessive finish has been allowed on the pattern, the ring will not clean up at all points, and where the cut is heavy, the ring will be thin after turning. To obviate this, the pattern is first made with the usual finish, as if the ring were to be solid and the same size as the cylinder bore.

Next, the pattern is sawed apart where the gap of the ring is to be, and a piece the size of the gap is inserted. This will spring the pattern outward to a noncircular form such that when the casting is cut and sprung inward for turning, it will be nearly a true circle in the rough, with a fairly uniform allowance for finish all around and with a gradually tapering thickness, as intended.

After being cut off and faced to thickness, the gap is cut out. The ring is then sprung together by a clamp on the lugs which are cast on the inside of the ring, then it is strapped to a face plate, or, better,



A=.0268d+.0893
B=.0312d+.25
C=.1071d+.1071
d=DIAMETER OF CYLINDER
ALL DIMENSIONS IN INCHES

DIMENSION OF SNAP PISTON RING

clamped between 2 flanges of a special fixture, and is put in the lathe and turned to the true size of the cylinder bore. When the clamp is relieved, the ring expands again, but not to a circular form. When placed in the cylinder, it resumes its circular shape, and is a fit all around. To secure the best results, the ring should be released from the face plate and be reclamped before making the finishing cut.

You state that in this particular instance, from ½ to 5/16 in. was cut out in making a gap. From the formula furnished on the accompanying sketch, which appeared in the June 3, 1909, issue of American Machinist, we obtain a gap width of 0.1071×14+0.1071= 1.605 in. for a ring for a 14-in. cylinder. It would seem that the gap, in your case, is rather small. Large numbers of rings have been made to these dimensions and with entire success—the extreme size made being of 28-in. diameter. W. P.

Punched or Drilled Rivet Holes

WHAT IS the relative advantage of punched or drilled rivet holes? SUBSCRIBER.

A. Rivet holes may be either punched, or drilled, or punched and reamed—the advantages of each method depending largely upon the quality and thickness of the metal. If the plate is thin and of wrought iron or very soft steel, it may be punched without serious

injury to the metal. Ordinary boiler steel, especially the harder grades, is injured by punching (the metal next to the hole is strained) and this method is not recommended for power boilers.

Drilling is more accurate than punching, but it is slower and costs more. Sometimes the holes are punched to a smaller size than the rivet and then reamed to the proper size. When this is done, at least 1/16 in. of metal should be reamed off, in order to remove the metal that is injured in the punching process. When properly done, punching and reaming gives a very satisfactory joint for plates ½ in. thick or less and is cheaper than drilling. O. H. H.

Replacing a Tank Rivet

IF A RIVET dropped out of a water supply tank, near the bottom, how can it be replaced with a bolt—that is, to have its head on the inside of the tank and put there without emptying the tank or going into the tank?

SUBSCRIBER.

A. One method would be to insert, in the rivet hole, a wooden plug with ⅛-in. hole in its center, which will allow a line and wire to be drawn through it. Before inserting the plug, however, a sufficient amount of fish line, to one end of which a cork is attached, should be pushed in ahead of the plug to allow the cork to carry one end of the line to the surface of the water.

Now, go up and remove the cork and connect a length of piano wire to the fish line, being careful not to make a joint which will be too large to be drawn through the hole in the plug. Fasten the bolt to the other end of the wire in such a manner that when drawn down to the rivet hole, it will not lie across the hole, but rest perpendicular to the side of the tank. In other words, the wire would be so connected that it will leave the bolt at the end and thus approach the rivet hole, end on, when drawn down to the plug. When it reaches the plug, the plug should be removed and the bolt pulled into position.

It is to be expected that some water is going to escape and that one is apt to receive a drenching with this method; but with a due amount of care, the bolt can be properly inserted. R. E. T.

Using Caustic Soda

WHAT EFFECT, if any, has caustic soda on boiler plate? In what proportion should it be fed with soda ash to remove scale? F. G.

A. Concerning the effects of caustic soda (sodium hydrate) and soda ash (sodium carbonate) on boiler plate, we would advise you to read "Caustic Soda and Boiler Corrosion," which appeared in the Feb. 15 issue. This article states that in 22 different plants investigated, caustic soda was suspected to be the cause of cracked plates and ruptures. Separate tests have proved that caustic soda liquor concentrated beyond 100 deg. Twaddell (specific gravity 1.5) tends to make mild steel brittle.

It would not be advisable to use soda ash with caustic soda. At low temperatures, soda ash is a stable salt; but at temperatures met in boiler practice, it is known to separate, giving off carbonic acid and thus becoming caustic soda and creating a superfluous amount of the substance which, as stated above, is known in concentrated amounts, to change the structure of the metal from a fibrous to a crystalline form, and make the shell brittle.

The exact proportion of caustic soda or soda ash which should be fed will depend upon an analysis of the water, and the amount should be just sufficient to counteract the effect of the scale-forming substances.

Peculiar Engine Performance

THE INDICATOR CARD shown herewith was taken from a 12 by 10-in. automatic high-speed engine direct connected to a 30-kw. 220-v. generator running at a speed of 320 r. p. m. and which, at the time, was carrying a load of 70 amp. There is a considerable pound having somewhat the nature of a rattle in the cylinder which increases in intensity with the load.

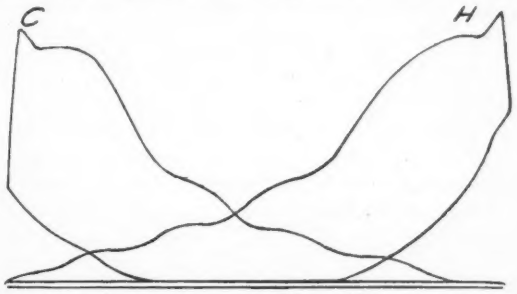
The piston has a clearance of about ¼ in. on both ends, so I am sure it does not strike the cylinder heads.

I would be pleased to have your opinion and suggestions for a remedy for this trouble. J. B.

A. This is a peculiar condition rather difficult to remedy without some re-design of the valve.

On both crank and head ends admission is late, and this is probably what causes the rattling pound, because the flywheel is pulling the piston for a short time after the engine reverses its stroke.

On the other hand, release is quite early on the crank end and somewhat early on the head end, so



PECULIAR CARD TAKEN FROM 12 BY 10-IN. AUTOMATIC HIGH-SPEED ENGINE

that turning the eccentric ahead to relieve the late admission would bring the release still earlier. This apparently is not desirable, as shown by the cards. It will be better, however, to have the admission ahead sufficiently to straighten up the admission line, even at the expense of bringing the release somewhat earlier and increasing the compression somewhat.

Compression is a good deal higher on the head end than on the crank end. For this reason, it would seem that the length of the valve rod might well be changed a little so as to bring the head end compression less and the crank end compression greater. This would mean moving the valve slightly towards the head end, provided the exhaust is on the inside of the valve, as is usual. Then the eccentric should be turned ahead so that the admission lines at the ends of the card are vertical instead of leaning inward. If you have a shaft governor, this may mean some considerable of a job; but it is the thing which ought to be done as indicated by the diagrams. A. L. R.

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For Our Country

From every loyal citizen of the United States, one allegiance is due: To the country whose benefits he enjoys. And, fortunately, the realization is growing that citizenship carries obligations as well as privileges; the obligation for each one to serve according to his ability for the welfare of all.

Whether one believes in "preparedness" as applied to military and naval affairs or not, he must sympathize with the efforts to put our industries on the best possible basis for economical production and to supply materials and labor from our own resources. And one lesson that the conflict in Europe has driven home is that cooperation of all classes of workers, whether with head or hand, in office or field, is essential to the success of a nation and its undertakings, peaceful or otherwise. With this must come coordination of resources and facilities to avoid duplication, waste, scarcity in some lines of production and over expansion in other lines.

With the democratic form of government, autocratic control is unlikely unless an emergency should arise which would win the consent of all to strenuous measures in order to meet it; hence, coordination must rest with private agencies such as national societies of workmen, engineers, scientists and employers. But such cooperation and coordination can be much helped by a favorable rather than unfavorable attitude of the government.

To secure the supplementing of present resources so that we may be able to supply our own needs for raw materials and manufactured products, it is necessary that the men of pure science push investigations of materials available and processes for treating and working them, so as to replace those heretofore brought from other countries. If economical manufacture is to be perfected, workmen must come to realize that the best returns to them, both in wages received and in what they can buy for those wages come from use of efficient methods and machines to replace muscular labor wherever possible. Loyalty must come to mean the effort to place our industrial life on a safe basis quite as much as provision for defense against possible foreign invasion.

Employers must learn and apply the lesson that the man who fits his work and is getting highest pay for his labor is more effective than the discontented man at low wages. And all must learn how to pull together for a common end, the best progress of Our Country.

Although this may sound like an ideal, every engineer knows the effect of friction in a plant, and the poor results that follow wrong planning and bad management. And the same principles apply in the running of our government and industrial organizations.

Noteworthy, as a step toward the fulfilment of the ideal is the cooperation among scientists and engineers who are certainly not of the leisure class or possessed of great wealth, to further scientific and industrial investigation. From the National Academy of Science, a National Research Council has been appointed composed of the most eminent men of science in all lines in the country, to secure efficiency in research that may make for scientific and industrial progress. And, in passing, it is well for us as engineers to recognize that commercial advance, except in a limited and inefficient

way, is impossible without the exact knowledge of Nature's laws which it is the effort of the pure scientist to discover.

Cooperating with this movement, The Engineering Foundation, which is directed by the national societies of Civil, Electrical, Mechanical and Mining Engineering has placed its resources for the coming year at the disposal of the Research Council, and representatives of the societies have been placed as members of the Council thus ensuring that the two classes of research as defined by Dr. Carty, investigations in pure science for free advancement, and industrial investigation for commercial application, shall each have its place.

This is a cooperation that is needed. It is high time that the scientist should take note of the needs of industry in directing his activities, and be ready to suggest wherein his discoveries may prove useful, while not neglecting the important work of seeking knowledge for its own sake even though the direct value of that knowledge may not be immediately evident. It is also high time that the "practical" man acknowledge freely his debt to the scientist and seek from him the answer to problems that seem impossible of solution for want of materials with which to work or facts on which to build up industrial methods. More and more has this interchange taken place in recent years, so that the present step is logical and welcome.

If this has become possible, there is surely hope that those who employ and those who are employed, may also find a means of cooperation for furthering the welfare of our industries. To place on a sure basis all activity in production of materials and manufactures by the best methods is a service to this country worthy of effort and sacrifice by every loyal citizen, and will be a most effective method of safeguarding its future against disaster in any form.

Opportunities for Young Engineers in Hydro-Electric Plants

To some engineers located in city stations operated by steam-driven units, a position in a hydroelectric plant looks like a species of professional exile. Many of the latter stations are located in remote places in the mountains or in valleys far from important centers of population, a few telephone lines being the only immediate means of communication with the outside world. The production of electricity by falling water looks surprisingly simple to many steam engineers, and it is only natural that sometimes they should question whether any future lies ahead of their brethren in the distant water-power stations.

In reality, there is a vast amount to learn in the operation of a hydroelectric plant, not only with respect to its own service but also in comparing the particular installation with which one is associated with others of its kind. The mastery of the local hydraulic scheme may not take long; but, as the months pass, with their changes in weather conditions, with the variations in stream flow, reservoir capacity, adjustment of flashboards, struggle in some climates against ice formation and in virtually all installations the continual attention required to conserve the machinery against depreciation due to unclean water or other causes, the operator finds much to stimulate his working resourcefulness.

Of course, in comparison with a steam plant, a modern water-power station illustrates a rather rigid design; errors in the original layout can seldom be economically corrected, and a development once completed usually has to remain as built, on account of the fixed charges involved. Nevertheless, every water-power installation has important lessons to teach the ambitious operator, who ought to acquire in such a plant a conception of the importance of overhead costs that will never leave him. That conception is a compensation at least in part, for the absence of those chemical processes on a grand scale that make the steam-driven station such an interesting study.

From many steam plants, but comparatively low-voltage service extends, whereas in a great many water-power stations, the problems of high-tension transmission, of safeguarding service continuity, and of maintaining normal frequency in the face of untoward load conditions are important parts of the daily routine. Knowledge of the electrical side of the hydro station delivering energy at extra high pressures is very much worthwhile, and may fit an operator to step into a position elsewhere that will be both remunerative and stimulating. A good many things happen on a high-tension system with which few of the brethren in city steam stations have any experience, and an alert young engineer can put in profitable service in a hydroelectric plant if the conditions are anywhere near favorable to intelligent study. Certainly one ought to find a station of this type a most attractive field for work during at least a year or two, perhaps more, and if the young engineer makes the utmost use of his opportunities, combining the study of his own installation with others of the water-driven type through the media of books, the technical press, and such intercourse as may be open to him, he is bound to become better prepared for future service wherever he may be located than if he allowed himself to fall back into purely routine work and failed to seize the opportunities so close at hand in the water-power station.

How the war has affected business in the principal belligerent and neutral countries is shown in a report prepared by the Bureau of Foreign and Domestic Commerce, Department of Commerce, for Senator Simmons, Chairman of the Senate Committee on Finance. The countries covered are the United States, Canada, England, France, Germany, Austria-Hungary, Italy, Russia, Spain, Sweden, Argentina, Brazil, Australia, British South Africa, Egypt and Japan.

To indicate the business activities of the various countries covered by the report statistics are printed, showing Imports and Exports of Merchandise, Imports and Exports of Gold, Receipts of Railways, Bank Clearings, Business Failures, Postal, Telegraph and Telephone Receipts, Building Operations, Production of Pig Iron, and Prices of Commodities. Complete figures could not be obtained for all countries, but as the report stands, it contains the most complete and reliable collection of statistics and diagrams that have been issued on the subject under one cover since the war started.

The report has been published as Senate Documents No. 477, and contains 75 pages.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Fero Electric Tire Pumps

ORIGINALLY the only use for compressed air in the garage was for the inflation of tires. Hence compressors designed for this particular service are now generally known as tire pumps. The field of application for these tire pumps has broadened, however, including such additional uses as, operating small pneumatic tools, spraying, blowing dust and dirt from cars, and in vulcanizing work. Although still designated as tire pumps, they are more rightfully compressors, and their use has become so general that they are now practically indispensable in the modern garage.

The compressors illustrated are of particular service

FERO ELECTRIC TIRE PUMP

in the private and small public garage. They are made by B. M. Fero, 509 Pennwood Ave., Wilkensburg, Pa. The complete line is designed to take care of the requirements of both private and public garages and service stations. Westinghouse alternating and direct-current motors are used exclusively in equipping these compressors, which are made in portable and stationary form in various sizes. The line includes:

Single-cylinder, horizontal, stationary compressor driven by a ¼-hp. motor, to meet the requirements of garages housing not more than 20 cars. When used in connection with an air tank of 20 gal. capacity, together with an automatic switch or controller, it enables the garage owner to have a complete up-to-date equipment at a relatively small investment.

Double-cylinder, portable, vertical compressor for direct inflation of tires, operated by a ¼-hp. motor displacing 1.8 cu. ft. of air at 500 r.p.m., with a pressure of 125 lb. per sq. in.

Double-cylinder, portable or stationary, vertical compressor with a ⅓-hp. motor or a 1.2-hp. motor, for direct inflation of tires or for use in connection with an air tank.

Heavy duty, double-cylinder, vertical compressor with a ¾-hp. motor. It is especially suited for operation in connection with an air tank. The motor is of the repulsion type with starting characteristics that make it particularly desirable, when automatically controlled, for starting against high tank pressures. It will start the pump against a tank pressure of 125 lb. and compress to 175 or 200 lb. tank pressure if desired.

Undoubtedly the greatest convenience and service is obtained when a motor-driven compressor is regulated by an electric pressure controller. It will unfailingly start the motor at the minimum pressure set for and stop it at the maximum pressure, insuring ample tank pressure, day and night, without attention other than an occasional oiling. The stationary form of compressors of this manufacturer, when designed for use in connection with an air tank and not for direct inflation, are furnished with suitable electric controllers when desired.

Boiler Water Purifier

RELYING upon heat to effect the precipitation of incrusting solids, a mechanical preheating device, known as the Economo Boiler Water Purifier, has recently been placed upon the market by the Boiler Water Purifier Co., Inc., of Philadelphia.

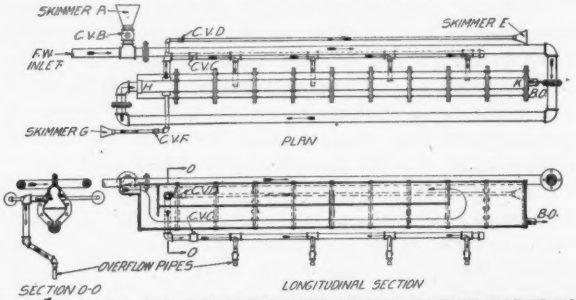


FIG. 1. PLAN AND LONGITUDINAL VIEWS OF THE ECONOMO PURIFIER

It is known that if the temperature of the water be raised from 60 deg. F. to 347 deg. F. (the temperature corresponding to 115 lb. gage pressure), the water loses about 89 per cent of its soluble power for calcium sulphate. The application of heat also causes a change in the composition of the salt from Ca SO_4 $2H_2O$ (gypsum) to Ca SO_4 (anhydrite) which is virtually insoluble at about 300 deg. F.

Advantage has been taken in the design of this purifier, of the conditions existing within the boiler to increase the temperature of the feed water, under pressure,

to a point where the sulphate is precipitated. Precipitation occurs within the purifier; the purified water then passes to the boiler and the sludge is blown out of the purifier. Owing to the peculiar construction of the purifier the sludge is blown out and the purifier cleansed with but little loss of water. Blowing every 4 hr. is recommended.

As indicated in the plan view of Fig. 1, feed water enters the purifier at the inlet I and also through the skimmers, A, E, and K. Water entering through the inlet or the skimmer, A, flows along one lateral, and, crossing at the end, returns along another lateral, entering the main compartment of the purifier at H. It

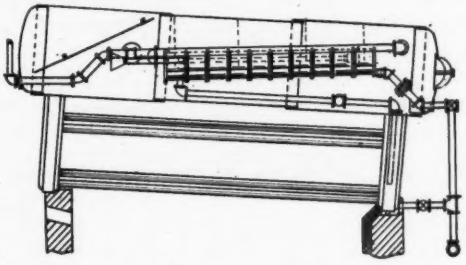


FIG. 2. ECONOMO WATER PURIFIER INSTALLED ON A WATER-TUBE BOILER

is diverted downward, as shown by the path of the arrow in the longitudinal view of Fig. 1, then passes through the lower chamber until it is permitted to rise and flow in reverse direction through the upper chamber. Connected to this upper chamber is the discharge manifold which distributes the feed water to the boiler through 4 overflow pipes.

This apparatus is claimed to prevent foaming in boilers, and, as the heated water is discharged near the bottom of the boiler, to act as a circulator and prevent unequal expansion.

It is designed for application to either water-tube or horizontal return tubular boilers. An illustration of a typical installation on a water-tube boiler is shown in Fig. 2.

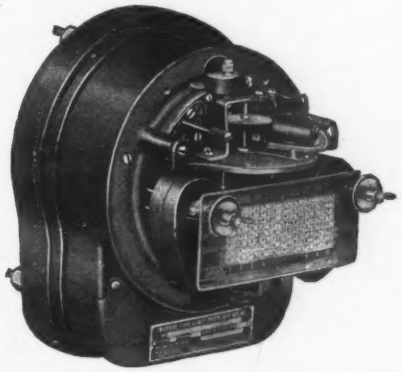
New Type Time Limit Overload Relay

THE single-pole time-limit circuit-closing overload relay shown herewith and made by the General Electric Co., is of instrument construction, simple and rugged. It is particularly applicable to those systems where extreme accuracy in timing is required for tripping 2 or more air or oil circuit breakers selectively.

Operating or characteristic curves for the various time-current settings are entirely separate and distinct at even the heaviest overloads and never become instantaneous. The heaviest overloads do not disturb the form of the curve nor cause vibration of the moving parts. The relay operates within a period of time which varies inversely with the lower current values and approaches a definite minimum time for the higher current values; consequently, the relay will do the work ordinarily required of time-limit relays, that operate within a definite time and those that operate in a time that is reduced as the current values increase.

The relay is designed for use in the secondary of current transformers. The normal load rating is 5 amp. By means of a current tap plate and a metal tap plug, portions of the relay winding are cut out so that the relay may be set to operate at 4-5-6-8 and 10 amp. Positive operation is obtained at any setting throughout this range.

Contacts are closed on overload by the rotation of a disk actuated by a "U" shaped driving magnet with shading coils on the pole pieces. No tripping current is carried through the revolving parts. When the contacts have been closed, they are firmly held in that position until tripping occurs, by the armature of a holding coil connected in series with the contacts, the trip coil of the air or oil break circuit breaker and an auxiliary switch which opens when the breaker is tripped. This insures current on the trip coil continuously until the circuit breaker opens, and prevents flashing at the contacts which, as an additional precaution, are of high heat resisting metal and noncorrosive, and therefore



GENERAL ELECTRIC TYPE I, FORM A, INVERSE TIME-LIMIT OVERLOAD RELAY

practically indestructible. The current closing capacity is extremely high for a relay of this type and ample for directly tripping any one circuit breaker made by the General Electric Co.

The values given in vertical columns 1 to 10 on the index plate are the time relays which will be obtained at the different degrees of overload represented in the "Times Current Tap Setting" columns at the extreme right and left side of the index plate. The factors appearing in the "Times Current Tap Setting" columns, when multiplied by the current tap settings, represent actual secondary current values.

To obtain a given current setting, it is only necessary to insert the metal tap plug in the current tap plate at the desired current marking. Time settings are obtained by moving a small lever in the front and near the top of the relay, to the graduation mark representing the column in which the desired time appears.

This relay is being furnished in 2 styles for 25 and for 60-cycle circuits respectively. The principle of operation and the inherent characteristics are the same in both and the relays themselves differ only in slight details of construction.

FOR HOT boxes, powdered sulphur mixed with mineral oil has been found to give relief.

News Notes

ANNUAL MEETING of the American Society of Mechanical Engineers will be held in New York City, Dec. 5 to 8, at 29 West 39th St. Among the papers to be presented are Proportioning Surface Condensers, by George A. Orrok; Testing of House Heating Boilers, by L. P. Breckenridge; Water for Steam Boilers, by A. C. Scott, on Wednesday morning. Waste Heat for Steam Generating, by Arthur D. Pratt; Graphic Analysis in Design and Operation of Steam Power Plants, by R. J. S. Pigott; Power Plant Efficiency, by Victor J. Azbe, on Wednesday afternoon. Gas Producer for Bituminous Coal, by O. C. Barry; Sampling and Gas Analysis by P. W. Swain; Internal Combustion Traction Engines, by A. A. Potter, on Thursday afternoon. Flow of Air and Steam through Orifices, by Herbert B. Reynolds; Analysis of Safety Valves in Marine Practice, by E. F. Maas; The Talbot Boiler, by Paul A. Talbot, on Friday morning.

On Friday afternoon at 2 o'clock there will be a public hearing on revision of the Boiler Code in accordance with the recommendation of the Code Committee that revision be made every 2 yr. to keep the Code in accord with advances in the art of boiler construction. This hearing will be carried over to Saturday and into the following week if necessary.

AT A RECENT MEETING held by the American Association of Engineers at Gary, Ind., which was attended by 37 engineers not members, and 3 members, the Gary Chapter of the Association was organized and 21 applications for membership secured. The total membership of the Association is now 1335, and it is expected that this will reach 1500 before Jan. 1, 1917.

WE ARE ADVISED by Dr. Karl George Frank, the American representative of the Siemens-Schuckert-Werke of Berlin, Germany, that that company is now building a 60,000-kv.a. generator wound for 6600 v. and operating at 1000 r.p.m. The generator is intended for the Rheinische Westphaelische Elecktrizitaets Werke, and will be delivered by April 1, 1917, which throws interesting light on the conditions of the German electrical industry in spite of the war. The 6600-v. energy will be stepped up to 110,000 v. for transmission in a 60,000-kv.a. transformer.

PLANS HAVE BEEN MADE by the Union Gas & Electric Co., of Cincinnati, O., and improvements are now in the course of construction, which will necessitate the capital expenditure of about $6,000,000. The chief feature of the work is the construction of a new power station; but in addition to this, it is planned to lay about 40 mi. of large, 3-conductor cables, and make additions to, and changes in, 8 substations. The new power station will be located on the site of the old West End Gas Works on the Ohio River, about ¼ mi. west of the Grand Central depot.

Two units of 25,000 kw. capacity each have been ordered from the General Electric Co., and provision will be made for 2 more of the same size. The turbines will be supplied with steam from 8 Babcock & Wilcox boilers of 12,600 sq. ft. of heating surface each, equipped with Westinghouse underfeed stokers and Sturtevant economizers. Generators have a rating of 31,250 kv.a., 3-phase, 60-cycle, 13,200 v., 1800 r.p.m. It is planned, with this new power plant, to furnish power not only for lighting and industrial purposes for the city, but transmission lines will be carried beyond the city limits, into Kentucky and Indiana, and as far north as Middletown, O. Sargent & Lundy, of Chicago, have charge of the engineering work.

NORMAN L. WARFORD, until Nov. 1 in charge of the Powdered Coal Department of the Anaconda Copper Mining Co., Anaconda, Mont., has now become identified with the Powdered Coal Engineering & Equipment Co., of Chicago, Ill., in the capacity of engineer in charge of construction. Mr. Warford is credited with having installed the largest powdered coal plant in the U. S., for the Anaconda Copper Mining Co., at its several works, wherein they burn approximately 1000 tons of pulverized fuel daily.

PROPOSITION has been made by some of the City Council of Seattle, Wash., to authorize condemnation proceedings against the Puget Sound Traction, Light & Power Co., looking toward the purchase of its system in Seattle, and the power plant at Snoqualmie Falls, the total representing an investment of some $6,000,000.

The city is running a municipal plant and system in competition, has now some 43,000 customers and an installed capacity of 13,400 kw., while the statement is made that the Puget Sound Co. has 18,000 customers in Seattle, mostly large consumers, and the Snoqualmie Falls plant has a capacity of 19,000 kw. The proposition to take over the lighting company's plant is made to avoid duplication of overhead and underground construction.

OTTER TAIL POWER CO., of Fergus Falls, Minn., has let a contract for its power house to T. & L. D. Libby Co., of Minneapolis.

U. S. CIVIL SERVICE COMMISSION announces an examination for aid, on Dec. 6 and 7, to fill vacancies as they may occur in this position in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., and the field, at salaries of $600 and $720. Subjects are elementary algebra, geometry, and trigonometry, general physics, elementary mechanical drawing, education, training and experience. Graduation from a mechanical training, technical, or scientific school or equivalent training in a scientific or technical laboratory is a prerequisite for consideration. Applicants must have reached their nineteenth but not their twenty-fourth birthday on the date of the examination, and must submit their photographs. Apply for Form 1312.

U. S. CIVIL SERVICE COMMISSION announces an examination for assistant engineer and inspector of weights and measures, on Dec. 13 and 14, to fill vacancies in the Bureau of Standards, Department of Commerce, for service in the field, at salaries ranging from $1000 to $1600, and vacancies as they may occur in positions requiring similar qualifications. Duties may include one or more of the following subjects: Test and investigation of weighing and measuring apparatus and methods including work with the Bureau of Standards track-scale testing equipment; mechanical drafting; work in

scale design; miscellaneous engineering and technical work. The position may require travel all or a considerable portion of the time. A prerequisite for consideration for this position is a degree from an engineering college of recognized standing in a mechanical, civil, or electrical engineering course, or that the applicant be in his senior year in such course. Applicants must have reached their twentieth but not their thirty-fifth birthday on the date of the examination, and must submit their photographs. Apply for Form 1312.

Books and Catalogs

THE MODEL T FORD CAR, by Victor W. Page, 300 pages, 5 by 7 in., 100 illustrations; New York, 1916.

This is a new revised edition, covering fully all points treated in the former edition, and with much additional matter pertaining specially to the 1917 model of the Ford car. It gives particulars in regard to every detail of the car, care, operation, repairing and adjusting, with full and minute directions and illustrations showing just how to go about every part of the work. Bound in substantial cloth covers, the price is $1.

GENERAL ELECTRIC CO.'S Bulletin No. 45,104, illustrating and describing the company's Type H subway transformers, was lately received.

CATALOG No. 37, of Greenfield Tap and Die Corporation, Greenfield, Mass., contains 270 pages on gages, taps, dies, threading machines and reamers.

A NEW BULLETIN, No. 300, describing Engberg vertical, self-oiling engines, was recently received from Engberg's Electric & Mechanical Works, St. Joseph, Mich.

FROM SUPERNO CO., INC., 52 Broadway, New York, we have received a preliminary catalog of Superno patented steel superheaters, which will be followed by a more extensive catalog early in 1917.

"GRIPWELL" PULLEY COVERING, a vegetable and oil compound in connection with which a specially prepared canvas is used, is discussed in a booklet from "Gripwell" Pulley Covering Co., 157 Cedar St., New York City.

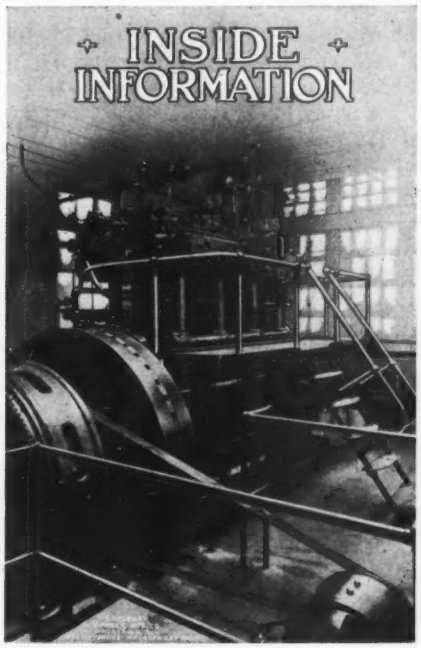
THE WORKER and the Works is the title of an interesting booklet being distributed by the Westinghouse Electric & Mfg. Co. In it is a brief account of the opportunities for advancement which are offered employes of the company and the welfare work which has been established in these great works.

HOW FAR will a trolley car coast and how long will it take it to come to rest after the power is shut off? How quickly can the motorman stop his car by the use of brakes? How much current does it take to start an electric car? How fast will an electric car run under a given voltage and current? Does it take more or less current to run a car fast than slow?

These questions and many others of a similar character have been studied by A. M. Buck of the Engineering Experiment Station of the University of Illinois and are answered in Station Bulletin No. 90 entitled "Some Graphical Solutions of Electric Railway Problems." Copies may be obtained gratis from W. F. M. Goss, Director, Urbana, Ill.

LINK-BELT SILENT CHAIN, transmitting power in the dye making industry, is the subject of Bulletin No. 282, relating to the 1000 drives installed in the plant of the Schoellkopf Aniline & Chemical Works, Inc., Buffalo, N. Y. The manufacturer is Link-Belt Co., 39th St. and Stewart Ave., Chicago.

INSIDE INFORMATION is the name of a new booklet just issued by The Bruce-Macbeth Engine Co., 2108 Center St., N. W., Cleveland. It is a handsomely printed book showing views of engine rooms in which



Bruce-Macbeth gas engines are in use, and giving a few definite figures and facts as to results that have been accomplished in the engine room with Bruce-Macbeth gas engines. A partial list of users is also given. A copy of the booklet will be sent to any interested party upon application.

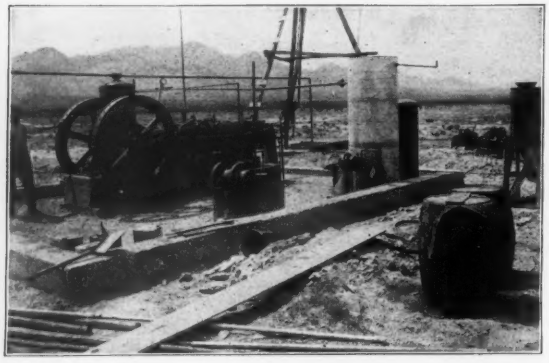
Trade Notes

THE ADAMS-BAGNALL ELECTRIC CO., of Cleveland, O., is completing an addition to its factory for enameling reflectors for industrial and street lighting. This porcelain enamel is laid on a steel sheet and is known under the trade name of Abolite.

THREE LARGE EXCITER UNITS are now being installed in the new power plant of the Buffalo General Electric Co., which have the interesting feature of a 300-kw. exciter to which is direct-connected on one end an induction motor and on the other end a Terry steam turbine. The governing mechanism of the turbine is arranged so that if power for the induction motor fails, the turbine will automatically pick up the load, and the exciters will take care of themselves without attention in case of trouble on the main circuits. If only motor drive is provided, the exciter unit will shut down as soon as the voltage of the main circuit fails, necessitating the starting of an independent exciter unit before voltage can be restored to the main circuits.

Another advantage of this duplex drive for the exciter is that the exciter unit can be driven from the main generator when the station load is light, so that the generator can easily take care of this exciter drive. Then, at peak load, when the main generator may be carrying full capacity on the external circuits, the exciter can be driven from the turbine, and at this time, the turbine exhaust can be used efficiently in the feedwater heaters. This is an item of considerable consequence with exciters as large as the ones described, 300 kw. normal capacity. The turbines are supplied with steam at 275 lb. pressure and 275 deg. superheat, which is another feature of interest. The steam turbines were manufactured and the units assembled by the Terry Steam Turbine Co., Hartford, Conn.

MANY LOCALITIES in the Southwest are dependent upon deep well water for all purposes; the problem of securing a sufficient and continuous supply has met with many mechanical difficulties but the satisfactory solution has apparently been found in the air lift well. The illustration shows an interesting installation on the



J. A. White ranch, 3 mi. northwest of Fort Bliss, near El Paso, Texas. Two wells, each about 600 ft. deep, with water standing 250 ft. from the ground level, furnish water for a town of 2000 inhabitants. The air is supplied by a Class N-SO compressor made by the Chicago Pneumatic Tool Co.

THREE LARGE motor-generator sets, each capable of delivering 10,000 amp. continually at 170 v., and a completely equipped switchboard were recently sold by the Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa., to the Cornelia Copper Co., for its leaching plant. The Cornelia Copper Co. is an offspring of the Calumet & Arizona Mining Co. and was formed to handle the low grade ores from the parent company's claim near Ajo, Ariz.

A 7000-hp. induction motor for driving a 16-in. plate mill, and a 4000-hp. induction motor for operating a 20-in. merchant mill, were recently sold to the Gary Works of the Illinois Steel Co. by the Westinghouse Electric & Mfg. Co.

Two 1500-hp., 3-phase, 25-cycle, 6600-v., adjustable speed phase wound Westinghouse motors were recently sold to the Carnegie Steel Co. for installation in its Duquesne Works. One of the motors has a speed range of from 218 to 145 r.p.m. and is to be used for operating 4 roughing mills. The other has a speed range of from 360 to 240 r.p.m. and is to be used for driving a 12-in. merchant mill.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigerator license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—Young man wishes position as oiler or assistant engineer in a plant in New York City. Two years' practical experience. Write William Brand, 24 Locust Hill Ave., Yonkers, N. Y. 10-1-2

POSITION WANTED—Chief engineer, experienced on Steam Turbines and Condensers, Corliss and Automatic Engines, A.C. and D.C. Generators, Transformers and Meters. Have built and operated plants with my own capital. Have Ohio First Class Engineer's license Issue No. 6. Will be at liberty in 30 days or before if necessary. Will come on one month's trial to prove my ability. Age 30. Address J. A. Wise, Mowrystown, Ohio. 10-15-1

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, A.C. and D.C. machines; strictly sober; 34 years old, married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Box 455, Practical Engineer, 537 S. Dearborn St., Chicago. 10-15-1

STEAMFITTER—Accustomed to high pressure work wants permanent situation. American and strictly sober always; am not afraid of plenty of work. Can work from blue prints, as well as do all kinds of general repairs. Have some experience in millwright work and some knowledge of steam engineering. H. L. Simonds, Box 166, Sac City, Iowa.

POSITION WANTED—Young, sober and reliable married man, as engineer. Six years' experience with A.C. and D.C. compression ice plants, Corliss, high speed and slide valve engines. Ambitious. Desire change where advancement is possible. Open October 1st. R. Bruce, Caruthersville, Mo. 10-15-1

POSITION WANTED—As oiler, by young man, age 21, single. Willing to accept position in any city. Address Peter Stanys, 670 W. 18th St., Chicago, Ill. 11-1-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WE WANT A SALES ENGINEER or first-class Specialty Salesman to represent us in different localities for the sale of a mechanical device for boilers for which there is a universal demand. Interested only in man now actually covering and soliciting power plant field, who has some general knowledge of boilers and who will tell in first letter what he is selling. A liberal commission insuring adequate compensation but only to desirable man. Be explicit regarding territory. Address Box 459, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 11-1-3-e.o.1

Wanted

FOUR COPIES of Practical Engineer for February, 1910, in good condition, we will extend your subscription for three months. Circulation Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio.

WANTED—One Direct Connected Unit, 750 to 850 kw., capacity 3-phase, 60-cycle, 480-volt, or Turbo Generator of equal capacity. Must be in A-1 condition. J. W. Wells Lumber Co., Menominee, Mich. 12-1-1

For Sale

ENGINES FOR SALE—One 12″x12″ New York Safety Engine, 280 r.p.m., Center Crank, Fly Wheel Governor and Band Wheel, each 48″ dia. x 12″ face. One 13″x12″ New York Safety Engine, 280 r.p.m., Centre Crank, Fly Wheel-Governor and Band Wheel, each 54″x12″. One 15½″x16″ New York Safety Engine, 250 r.p.m., Centre Crank, Fly Wheel Governor and Band Wheel with Extra Heavy Rims, 72″x12″. Two Type W. G., No. 7, 500 Volt, 120 Amp., Wood System, Bipolar Generators, 1200 r.p.m., with Rheostats and Wooden Bases. The above are all in good running order and will be sold at very reasonable prices. Apply to Hornell Electric Company, Hornell, New York. 12-1-1

HOISTS FOR SALE—Three Type S-3, 3-ton, 220 D. C. Sprague electric hoists, motor driven trolley, 50 ft. lift, variable speeds. M. H. Ripton, general contractor, 609 Livingston Bldg., Rochester, N. Y. 12-1-1

FOR SALE—Two 75 K.W. 250 V., 270 r. p. m., direct connected Ridgway Sets, engine 14x14, fine shape. One 400 K.W., 250 V., 360 r.p.m. Generator. Contractors Machinery & Stg. Co., Seattle, Wash. 12-1-1

FOR SALE—1 72-hp. Erie City High Speed 325 r.p.m. Automatic Engine; 2 boilers, 1 steam feed pump, one injector, 1 iron water tank. Zoar Battery Co., Zoar, Ohio. tf.

GAS ENGINE FOR SALE—One 15-hp. 2-cylinder Westinghouse gas engine for sale in good condition. No reasonable offer refused. Correspond with E. B. Latham & Co., 4 Murray St., New York City. 15-15-6

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch for model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

The number of manufacturers who view advertising in the light of expense is growing smaller day by day.

Advertising was not always considered a legitimate means to attract business—indeed, there was a time when it was an object of taxation in some countries. But now it is the vanguard of business. It heralds Civilization itself. The reclamation of vast acres of waste lands has been made possible by interesting the public in the project. Towns have been populated—railroads have been extended and although not yet equalized, a better balance between farm and city life has been attained all of which is based primarily upon advertising.

There is example after example in Business where a discontinuance of advertising has caused a material reduction in the "Good Will' and "Profits" of a firm.

Only recently a concern manufacturing a food commodity which has not been heard of lately, though widely known a few years ago, has instituted a large advertising campaign involving the expenditure of thousands of dollars simply to put its product before the public eye again and to bring it back into popularity and national usage.

This manufacturer sought to economize, discontinued advertising and lost his foothold on business—was unable to "clinch the markets." His so-called economy has cost him dearly. Had he kept on advertising, his markets would have been extended still further with the present appropriation, but now his advertising is only "regaining old grounds." Another manufacturer who discontinued advertising found it impossible to "come back" in this country so strongly were his competitors entrenched.

Advertising can put firms, cities and individuals, on the map and can keep them there as long as it is used consistently, but if it is ignored in the general order of things it results in a shrinkage of dividends and sometimes a complete dissolution of business.

You readers have been educated to buy the advertised products. It is no wonder that you view with an air of suspicion any product that is offered for sale without the backing of clean advertising.

It is only just that you patronize advertisers and by so doing protect yourself, as well as lend a hand to bigger and better business.